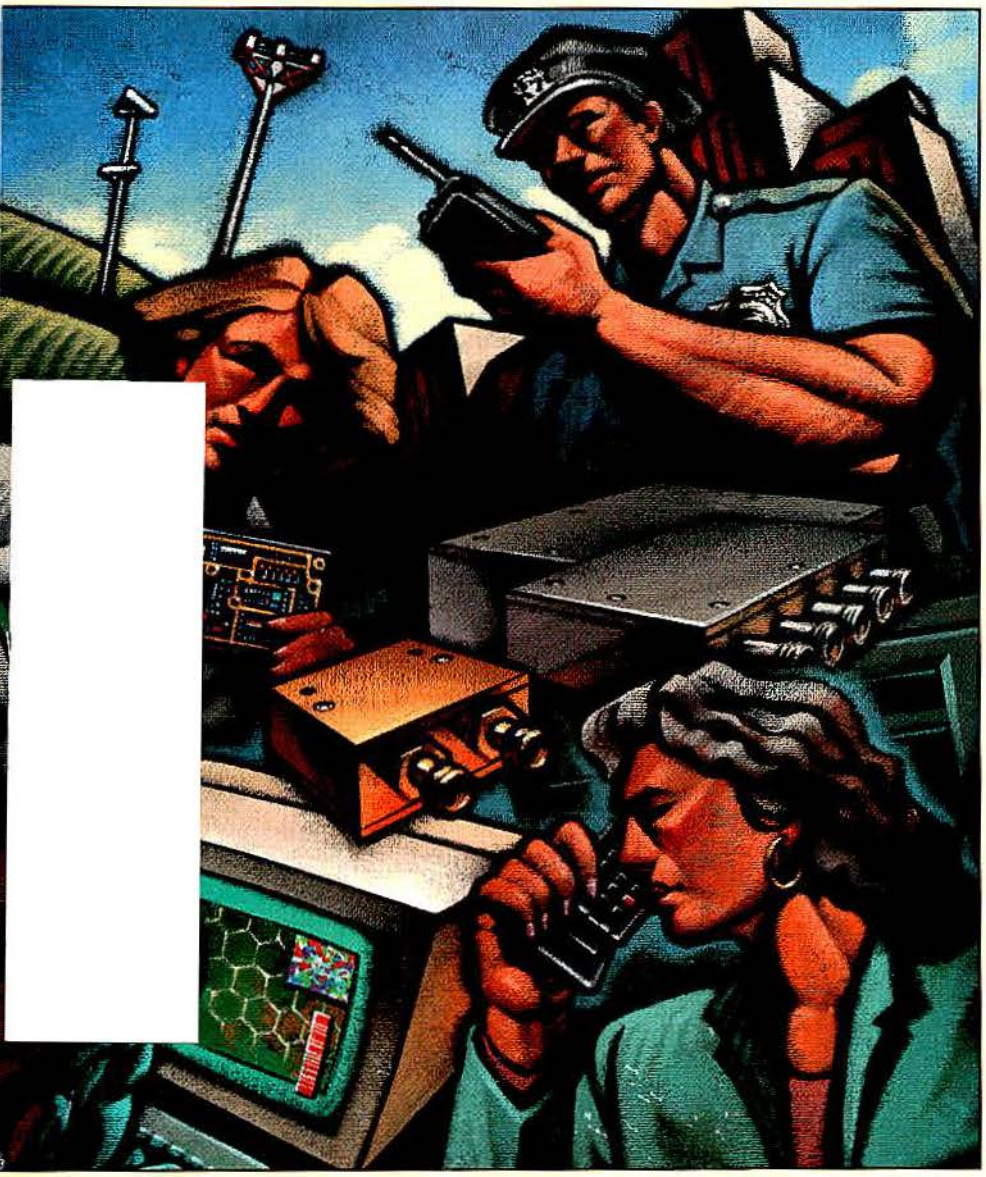
May 1997

# Mobile Radio Technology®

Technical information for paging, SMR and private wireless networks.

## Triaxial radiating cable, p. 10



Refarming progress report

Servicing pagers

Battery technology

220MHz networks

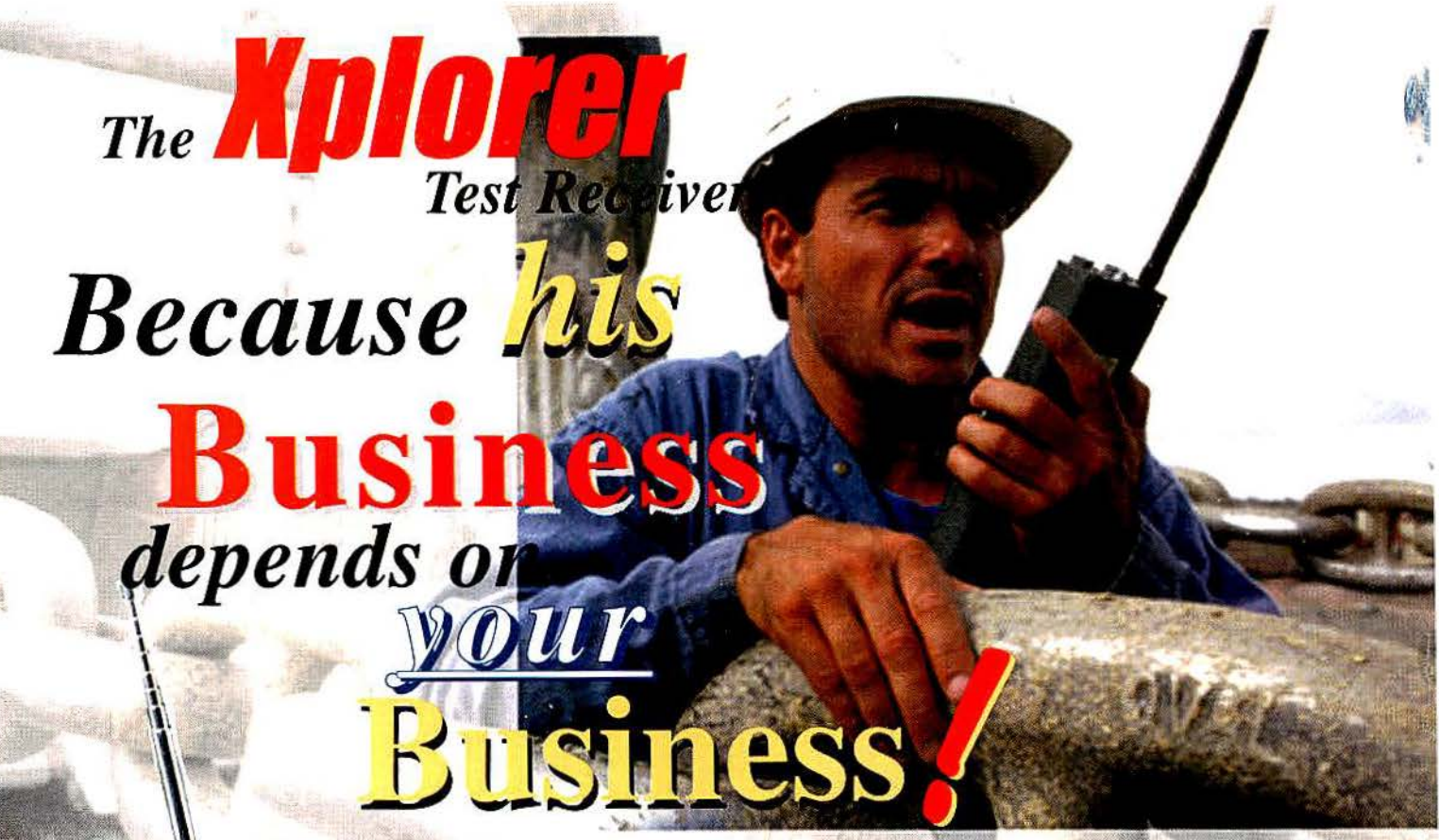
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Cable connection repair

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CTCSS Display




DCS Display




DTMF Display

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Frequency Range: 30MHz -2GHz
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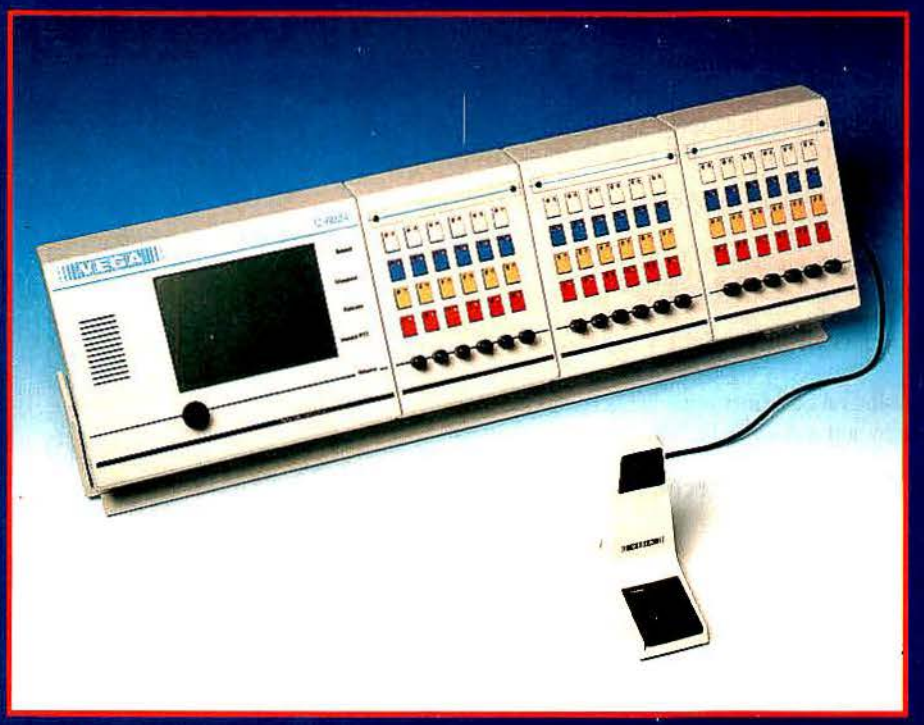
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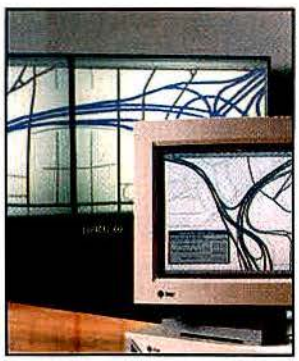
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**On the cover:** From public safety hand-helds to computer-aided dispatch, wireless mobile communications is playing an ever-increasing role in society. *Artist: Eric Peterson.*

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# The Landscape of Radio is Changing

The migration from analog to digital communication is altering the landscape of the radio industry. Transcrypt International has positioned itself at the center of this evolutionary process by manufacturing a radio which incorporates the latest in analog and digital technology.

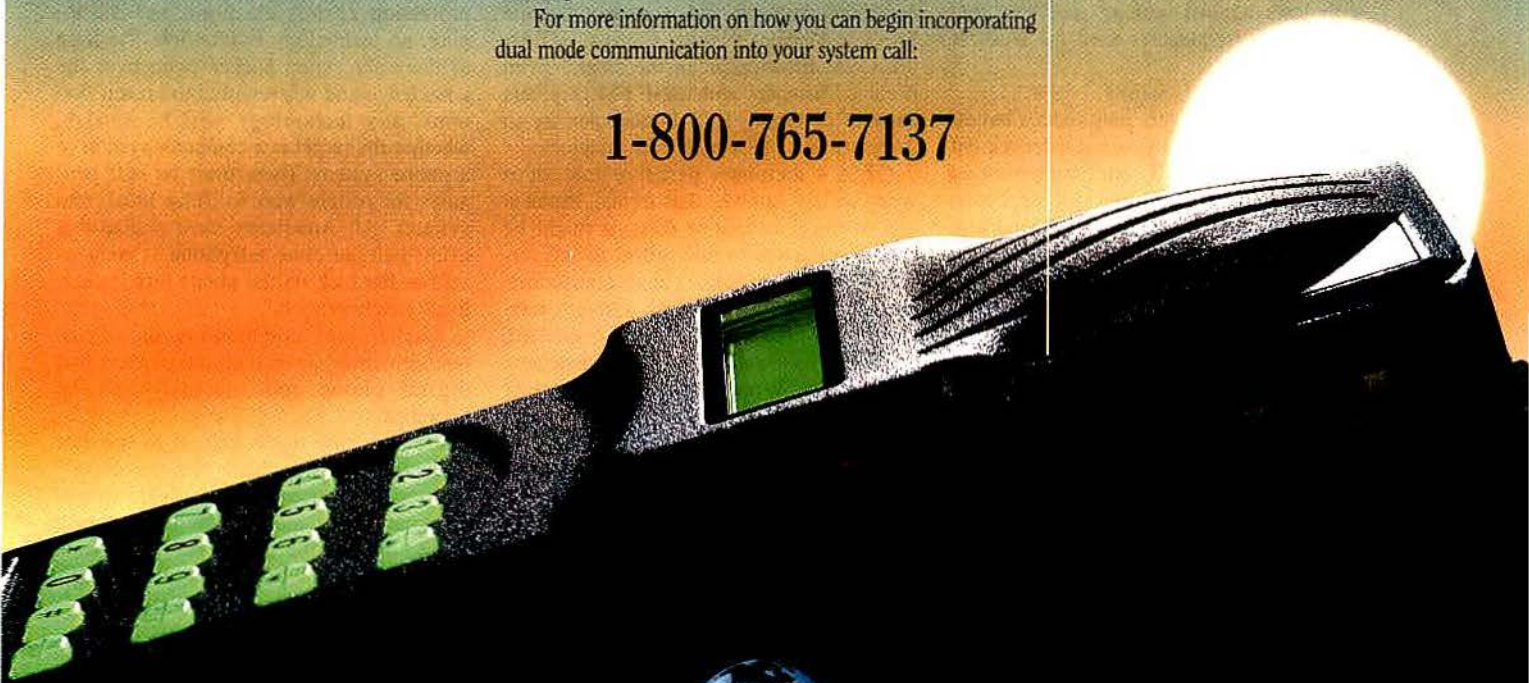
With two modes of operation, Transcrypt's Stealth 25 portable radio bridges the gap between digital and analog communication. Radio users can switch seamlessly from APCO 25 digital to a conventional analog channel or Motorola SmartNet™ trunking with one simple turn of the mode switch.

The Stealth 25 also offers several very important security options. For wide range radio compatibility, the Stealth 25 can be optionally equipped with digital encryption standards which are compatible with Motorola's DES and DES XL™ as well as APCO DES. Along with encryption security, the Stealth 25 comes equipped with Transcrypt's own Crypto-Voice-Plus® scrambling technology.

In addition to voice security, each Stealth 25 portable radio is manufactured with a sixteen button keypad. The radio is fully keypad programmable and offers authorized users the ability to reprogram features such as frequencies, CTCSS, and DCS manually.

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Circle (5) on Fast Fact Card

# Much ado about wireless telephone privacy



News reports and a Congressional hearing that resulted from the monitoring, recording and publicizing of a conference telephone call among leaders of the U.S. House of Representatives, one of whom was using a cellphone that was monitored, have led to renewed efforts to restrict radio receiver manufacturing. Proponents of the restrictions want to "improve privacy" with laws against making receivers that can tune to frequencies used for wireless telephone calls.

This approach is wrong.

Restricting receivers may reduce eavesdropping conducted by casual listeners, but one's privacy normally isn't compromised by casual listeners. *Casual* listeners who may intercept telephone calls generally don't know the people whose calls they hear. Most phone calls are as boring as you might expect. The novelty of hearing phone calls usually wears off quickly, and casual listeners move on to monitor unrestricted public safety frequencies.

*Purposeful* listening to wireless phone calls by people who intend to use what they hear to commit burglaries, bank fraud, credit card fraud, cellphone cloning, and industrial and political espionage isn't reduced by receiver restrictions. In some cases, purposeful listeners use commonly available scanners. In others, they use specialized equipment or test equipment that isn't restricted, anyway. Unrestricted scanners can be purchased in other countries and brought into the United States by those who are intent on monitoring wireless phone calls for harmful purposes.

Wireless phone users are more concerned with the rate they pay for calls than they are about the privacy of the calls. Many people use wireless phones in crowded areas where strangers overhear their side of the conversation. It doesn't seem to inhibit them.

There is more to lose in the restriction of receiver manufacturing than there is to gain in the uniformed effort to stop purposeful listening with a broad initiative.

### Dueling trade associations

As a sidelight, it is amusing to see the Thomas Wheeler and Jay Kitchen jockey for position on the issue. Wheeler is president of the Cellular Telecommunications Industry Association (CTIA), which largely represents cellular carriers. Most cellular carriers still use analog FM to carry phone calls between cell sites and cellphones. Using analog FM can be described as broadcasting "in the clear," meaning anyone using an ordinary UHF FM receiver can hear the voices.

Kitchen is president of the Personal Communications Industry Association (PCIA). Among companies PCIA represents are the new personal communications service (PCS) telephone carriers. PCS carriers use digital technology, including code-division multiple access (CDMA), time-division multiple access (TDMA) and global system for mobile communications (GSM, formerly Groupe Speciale Mobile). Neither CDMA, TDMA nor GSM broadcasts "in the clear." Even if casual listeners with UHF FM receivers capable of tuning PCS frequencies try to listen, they cannot hear conversations.

CTIA's members perceive that, if it were widely known, that casual listeners can overhear cellphone calls, it might be counter effective to their effort to sell service to more people. These restrictions perpetuate an *illusion* that wireless telephone conversations cannot be overheard, whether by casual or purposeful listeners. As a result, Wheeler advocates receiver restrictions. PCIA's members use a technology that protects them from casual listeners. As a result, Kitchen is much more relaxed about casual listeners, suggesting that worried cellphone users might switch to PCS service offered by his organizations's members!

### Privacy? Who cares?

Meanwhile, wireless phone users themselves don't seem to be that concerned about privacy. An informal survey of 150 cellphone users conducted by the Consumer Electronics Manufacturing Association (CEMA), a part of the Electronics Industries Association (EIA), found that most wireless phone users believe that conversations on cellphones are less secure than on their wired phones at home. Lower rates are more important than privacy to most of the users who were surveyed. Fewer than one out of four would pay a 20% premium for a 100% secure cellphone. Only 15% of the respondents considered privacy most important. Cost was most important to 36%; service reliability was most important to 29%, and clarity was most important to 15%. The survey was formulated by CEMA and was fielded by Verity Group, Fullerton, CA. The results have a margin of error of ±5%.

It would be better to leave the receiver manufacturers alone. Let them make receivers that can pick up shortwave FM broadcasts "in the clear," such as analog FM cellphone calls. Make telephone customers aware that their calls could be overheard by casual listeners unless they use a digital service. Remember, purposeful listeners, the ones with the greatest potential to do harm, will be listening regardless of receiver restrictions.

Quoting Kitchen: "There is no doubt that 100% digital PCS technology offers a much greater level of security than the older technology of the analog cellular phone. However, while this advanced wireless technology offers the optimum in protection against electronic eavesdropping, no technology is infallible. As long as there are expert hackers who have the knowledge and wherewithal to breach systems, any technology will be at risk, whether the target is a computer system or a phone system. There must be stiff penalties for people who willfully break into systems. All Americans must realize that even their wireline telephone is only as safe as the lock on the phone box in their local neighborhood."

Kitchen was commenting on an announcement by several cryptographers that digital phone code security can be breached.

Previous law made it legal to monitor conversations broadcast "in the clear." Previous law also made it illegal to use information obtained by such monitoring and to divulge the information to anyone else. The previous law allowed casual listening, and that was a better state of affairs than this current march toward more and more restrictions on receiver manufacturing and use.

*—Don Bishop*

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# Calendar

## 1997

### May

**5–7—Vehicular Technology Conference,** sponsored by IEEE Vehicular Technology Society, Hyatt Regency at Civic Plaza, Phoenix. Contact: Wendy Rochelle, 908-562-3870; Fax: 908-981-1769.

### June

**2–5—Expo Comm USA/Comdex/Spring '97,** sponsored by E.J. Krause & Associates, Georgia World Congress Center, Atlanta. 301-986-7800.

**2–5—Supercomm,** sponsored by USTA and TIA, New Orleans Convention Center, New Orleans. Contact: 202-326-7300.

**3–5—Canadian Wireless,** sponsored by the Canadian Wireless Telecommunications Association, Montreal. Contact: 613-233-4888.

**8–12—IEEE International Conference on Communications,** sponsored by Bell Canada, Nortel Technology, Stentor, Motorola, Alcatel, Lucent Technologies, Teleglobe Canada, BellCore, Harris Farinon Canada , Bell Canada International, BCE Mobile Rogers Cantel and VISTAR; Palais des Congrés, Montreal. Contact: 905-615-6507.

**9–11—Communications Expo/Show of the Americas,** Miami Convention Center, Miami. Contact: Jackie Gonzales, 305-412-9000.

**22–26—UTC National Conference & Exhibition,** sponsored by UTC, The Telecommunications Association, Oregon Convention Center, Portland, OR. Contact: 202-872-0030.

### August

**10–14—International Association of Public-Safety Communications Officials (APCO) National Conference,** Charlotte, NC. Contact: 904-322-2500.

### September

**10–12—Personal Communications Showcase,** sponsored by the Personal Communications Industry Association, Dallas Convention Center, Dallas. Contact: 800-326-8638.

### October

**27–29—Wireless Apps,** sponsored by the Cellular Telecommunications Industry Association, Seattle Convention Center, Seattle. Contact: Francesca Dea, 702-739-4025, or Tim Ayers, 202-736-3203.

### November

**6–7—AMTEX ,** sponsored by the American Mobile Telecommunications Association, Hilton at Walt Disney World Village, Orlando, FL. Contact: 202-331-7773.

**6–8—Second International Congress on Commercial Trunked Radio,** sponsored by the International Mobile Telecommunications Association, Hilton at Walt Disney World Village, Orlando, FL. Contact: 202-331-7773.

**12–16—Communications Marketing Conference,** sponsored by the Communications Marketing Association, Holiday Inn International Drive Resort, Orlando, FL. Contact: Bernie Brownson, 303-371-8182.

**21—Radio Club of America,** Communications Symposium, 88th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Gerri Hopkins, 908-842-5070.

## 1998

### February

**23–25—Wireless,** sponsored by the Cellular Telecommunications Industry Association, Georgia World Congress Center, Atlanta. Contact: 212-964-7000.


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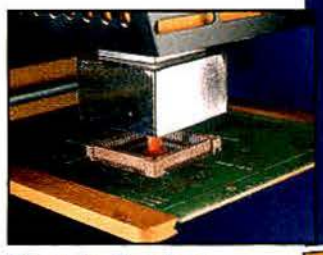
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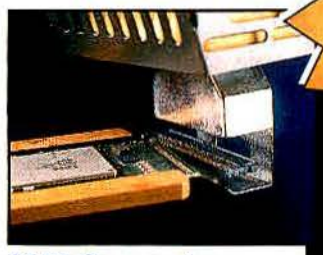


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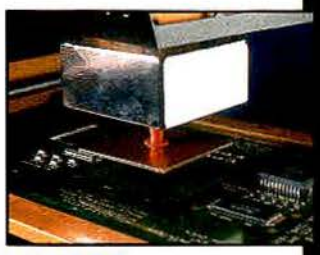
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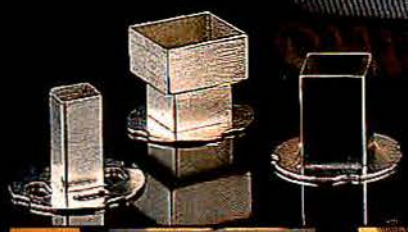


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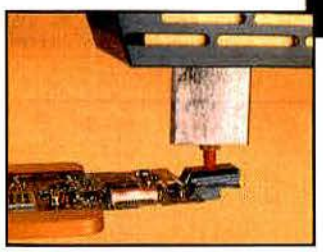
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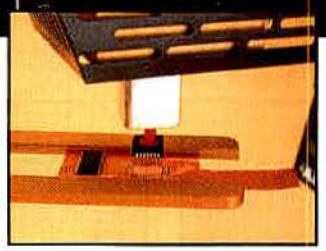

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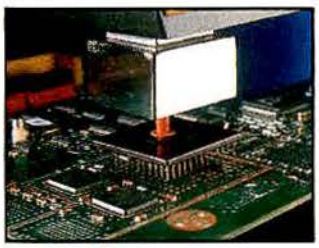
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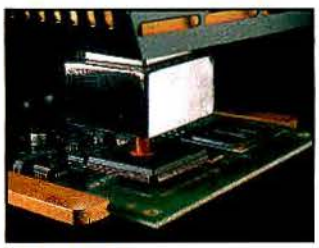
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# Co-channel interference: How bad is it?

By Harold Kinley, C.E.T.

*[Editor's note: Contributing Editor Harold Kinley, C.E.T., will present "Resolving RF Interference Problems" at IWCE, Las Vegas, Tuesday, April 22, at 2:30 p.m. Because of the advanced publication date for this issue, we are reprinting one of Kinley's classic columns on interference. A new column will appear in June.]*

As the land mobile radio frequency spectrum has become overcrowded, interference has become the rule, rather than the exception.

Years ago, it was common for land mobile radio users to operate strictly with carrier squelch. Although some users still get by with carrier squelch systems, their numbers are dwindling rapidly, and the time is fast approaching when it will be virtually impossible to operate without some kind of coded squelch system, digital or tone.

## Classes of interference

Basically, interference can be classified as either of two types, *nuisance* or *destructive*.

Nuisance interference is heard in the absence of desired signals, but it does not significantly degrade the desired signal.

Destructive interference causes serious degradation to the desired signal, or even blocks it.

Although a coded squelch system does alleviate most of the *nuisance* interference problems, it is *not* the great panacea that it is perceived to be by most nontechnical, and even some technical, people. It does nothing to alleviate problems caused by destructive types of interference.

Even nuisance interference can become harmful if allowed to go untreated. For example, a user who is constantly annoyed by noise or other undesirable signals often will turn down the radio's volume control or adjust the carrier squelch control to the maximum position, thus seriously desensitizing the receiver to even the desired signal transmissions.

At this point, the nuisance interference has become harmful. A coded squelch system is the logical solution to this type of interference.

There is not much use in crying to the FCC about nuisance interference *unless* it is caused by an improperly or illegally operating transmitter that you can identify. You will not get much sympathy—especially if you are operating carrier squelch only.

Destructive interference is another matter.

Normally, great care is taken by the duly authorized frequency coordinators to eliminate or to greatly reduce the likelihood of interference between two users operating on the same frequency.

In spite of the best efforts to avoid interference between co-channel users, problems often occur. Most of the problems are of the nuisance type and can be solved by using different codes on coded squelch systems.

## Compromising solutions

With destructive interference, a different approach is required. The best method of combating co-channel destructive interference is for the two co-channel users to meet and to work out an arrangement that is mutually beneficial and acceptable to both parties.

Some of the factors that might be adjusted to minimize interference include

*(continued on page 66)*

Material in this column originally appeared in *MRT* in May 1993. Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301. Kinley's email address is *hkinley@aol.com*.

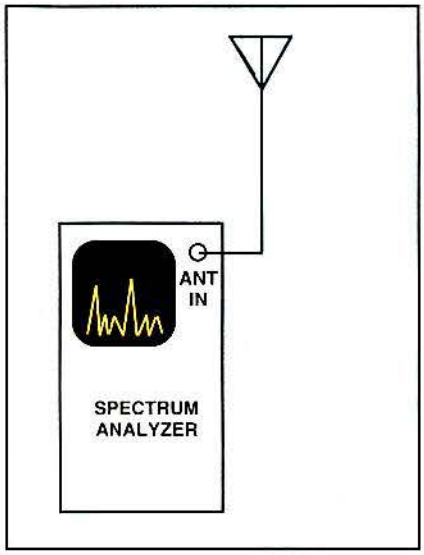



**Figure 1. This simple setup can be used to measure the offending interfering signal's amplitude. The spectrum analyzer must be capable of *absolute* (dBm) measurement and not the simple *relative* dB indications on some imitation spectrum analyzers that are a part of some service monitors.**

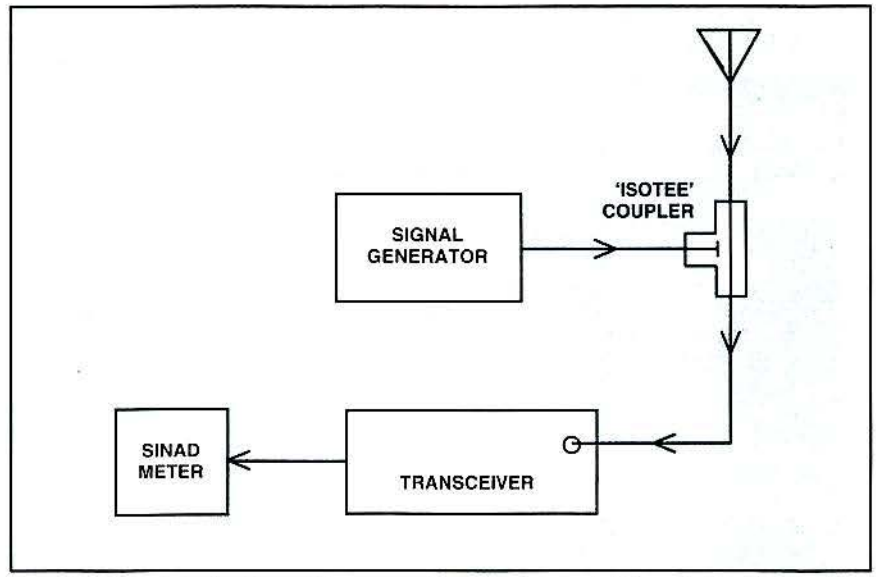



**Figure 2. This setup can be used to measure the actual amount of degradation that the interfering signal causes to the desired signal. For example, suppose that in the absence of the interfering signal, a generator output level of −60dBm is required to produce the 12dB SINAD level. Also suppose that in the presence of the interfering signal, the generator output must be increased by 20dB to −40dBm to return the SINAD meter reading to 12dB SINAD. This means that the interfering signal is *degrading* the desired signal by 20dB.**

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# Triaxial radiating cables improve subway communications

*Achieving proper radio frequency coverage for emergency police communications has become an increasing concern for subway transit authorities. Electrical, mechanical and combustion characteristics are important.*

**by Anthony Fedor**

Obtaining adequate radio coverage in enclosed areas such as subway tunnels and underground transit stations poses a challenge. The use of point-source antennas results in dead spots, and RF energy will not propagate along the length of a tunnel.

Many terms such as radiating cables, leaky feeders and antenna cables have been used to describe a cable designed to provide RF coverage in enclosed or confined areas where point-source antennas are not practical. These cables have been used as a way to provide RF coverage for two-way radio, paging, cellular and, most importantly, radio communications for police and emergency workers in the event of an accident or fire within a tunnel or enclosed area.

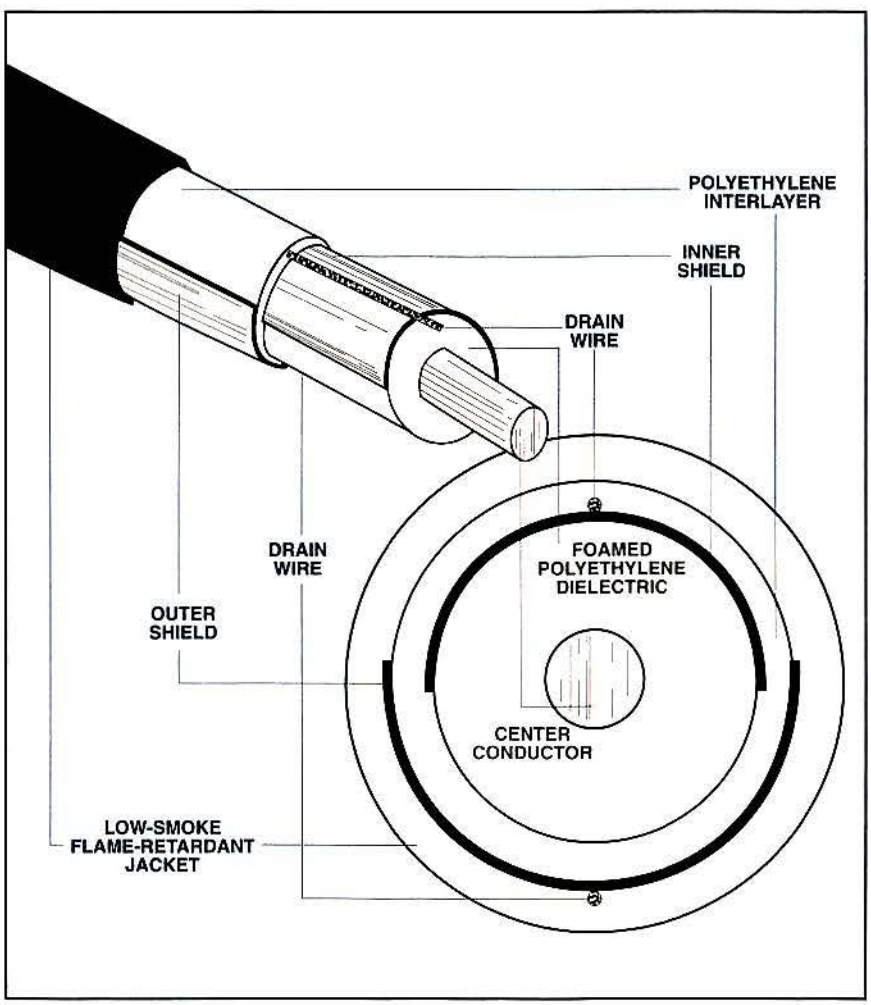



**Figure 1. A cross-section view of the triaxial antenna cable.**

In 1985, the New York City Transit Authority (NYCTA) began a system-wide upgrade of its transit police radio system. This upgrade involved the removal of an existing twin-lead antenna cable and replacing it with radiating cable. The NYCTA was looking for improvements in coverage of communication dead-spots within the tunnel system, improved reliability and the capability to add communications for other purposes in other frequency bands.

The NYCTA approved two radiating cable constructions to replace the existing twin-lead design. One construction was the traditional slotted corrugated copper design. The second construction was a split-shield triaxial design. After testing and qualification, the low-smoke-producing, flame-retardant triaxial design was chosen over the conventional slotted corrugated design for the IRT, the largest portion of the New York Subway System, extending into all five boroughs.

Fischbach and Moore Transit Group was chosen to install the more than 300,000 feet of TRC-1250-size cable (1.760" outside diameter) that was used. Because of the height restrictions within the tunnel, a maximum reel size of 72 inches was allowed, which provides as much as 2,000 feet of continuous length to be installed before any connector attachment is needed. These cables are

Fedor is product manager, cable, for Times Microwave Systems, Wallingford, CT.

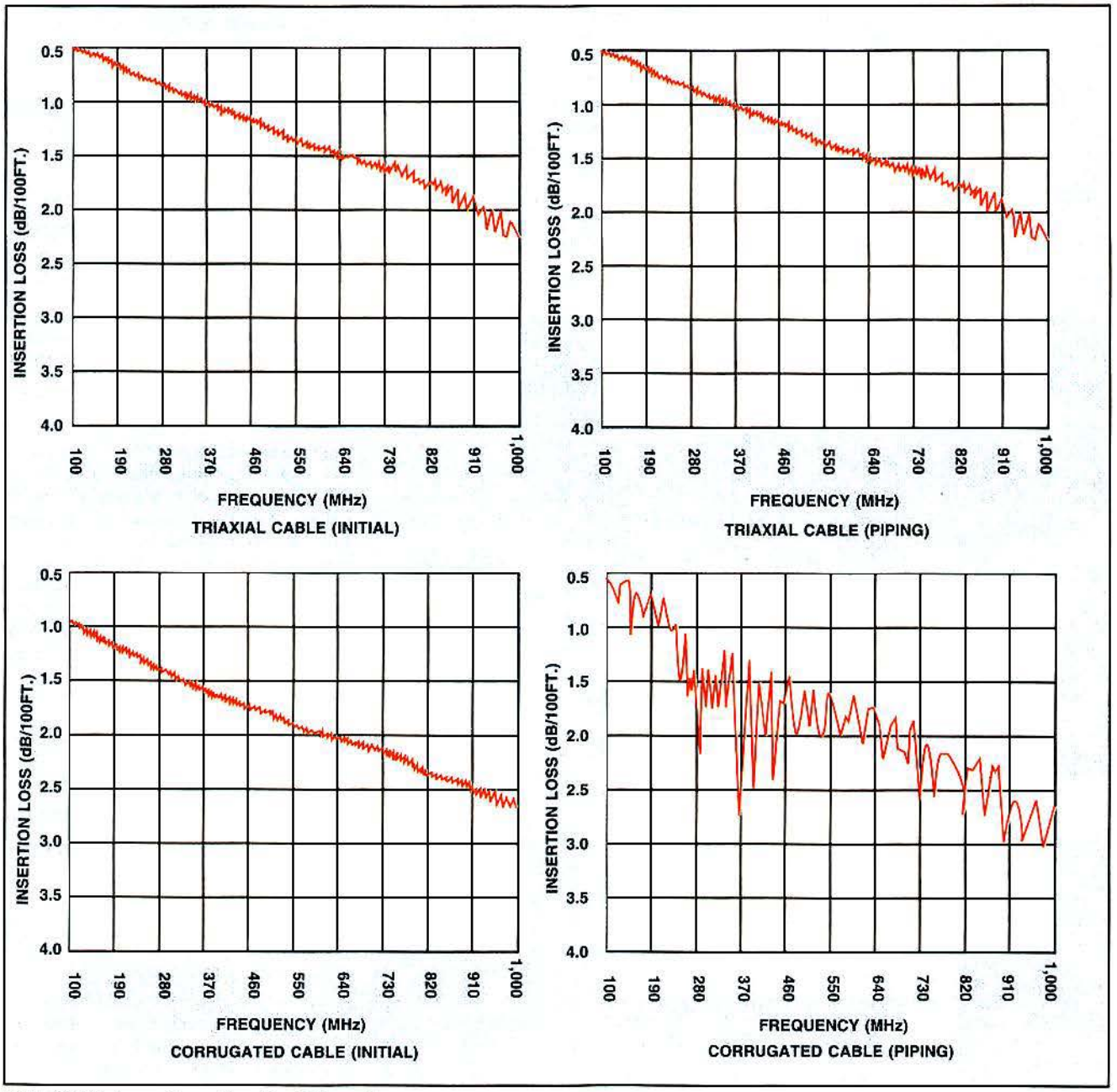



**Figure 2. Effects on attenuation of radiating cables.**

directly mounted to tunnel walls, providing easier installation.

### Cable design

As with all RF cables, the most important function of a radiating cable is to transmit RF energy from one point in a system to another with minimal degradation or loss of signal power. The difference between radiating transmission lines and conventional shielded coaxial designs is that this cable must also allow a controlled amount of RF energy to couple out of the cable and into the surrounding environment without sacrificing too much in downline attenuation.

Figure 1 on page 10 shows the construction of the triaxial cable design. Depending on the cable size, either a copper-clad aluminum conductor or a hollow copper tube is used for the center conductor. The dielectric material is a high-velocity, closed cell structure of foamed polyethylene, which offers a tough, low-loss medium for the transfer of RF energy between the center and outer conductors. The outer shields consist of a semicircular bonded smooth aluminum tape, which is separated by a layer of solid polyethylene. Braided drain wires are used to provide contact with the two outer shields when connectors are attached.

The outer jacket consists of a dual extrusion of low-smoke, low-toxicity polyolefin material. This proprietary flame-retardant material offers a tough weather- and ozone-resistant jacket, while maintaining the flexibility that is required when installing these cables within enclosed areas.

### Theory of operation

All radiating cables are affected by their environment. The environmental effect on the cable is a degradation of downline attenuation and coupling loss of varying de-

grees. The extent of the degradation depends on both the cable design and the environment in which it is installed. Cable performance will exhibit different results under different conditions, such as free space, inside a building or next to a conductive or high-dielectric-constant material (such as lying on the ground or attached directly to a tunnel wall.) The triaxial cable designs exhibit a more stable and predictable performance over these environmental conditions than the conventional slotted corrugated designs because of the different operating mechanisms. With the corrugated constructions, rows of milled openings are created, which provide a means for coupling energy to the surrounding environment. These rows of oval apertures occur periodically along the length of cable and, therefore, contain electromagnetic fields that have a component in the direction of propagation of the cable, which results in the total energy not being transmitted in the transverse electromagnetic mode (TEM). With the triaxial design, the aperture that is created by the separated shields does not store energy but transfers a small amount of energy to the outer surface. These cables are continuous and, therefore, have no fields in the direction of propagation. Figure 2 on page 11 demonstrates the effects of a section of steel piping on the attenuation performance of the two radiating cable designs. Both constructions exhibit similar attenuation characteristics from 100MHz through 1,000MHz. With the introduction of this piping at the input end of the cable, the triaxial design was virtually unaffected, whereas the slotted design showed a significant effect. This is important to system installers because cable standoffs are no longer required, decreasing cable installation costs.



More than 300,000 feet of TRC-1250-size cable was used in the IRT, the largest portion of the New York Subway System, which extends into all five boroughs. The low-smoke-producing, flame-retardant triaxial design was chosen over the conventional slotted corrugated design.

*The attenuation and coupling loss of the triaxial cable is controlled by the separation of the split shields.*

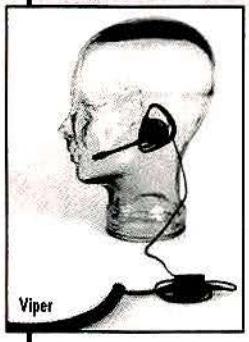
An added benefit of direct mounting is the elimination of hanging cables, which offers a more appealing cable installation. Another benefit is the additional protection from the effects of vibration and damage from contact with moving vehicles.

**Electrical performance**

The attenuation and coupling loss of the

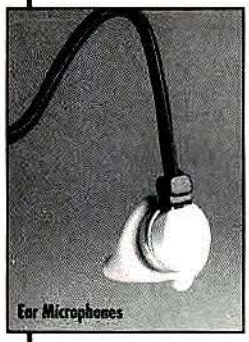

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| Table 1—Triaxial cable electrical characteristics. | | | | |
|---|---|---|---|---|
| ELECTRICAL TESTING | | TRC500-FR | TRC875-FR | TRC1250-FR |
| IMPEDANCE | | 50 OHMS | 50 OHMS | 50 OHMS |
| VELOCITY OF PROPAGATION | | 86% | 88% | 88% |
| ATTENUATION | @150MHz | 1.08 | .52 | .39 |
| | @450MHz | 2.00 | .97 | .78 |
| | @900MHz | 3.05 | 1.75 | 1.23 |
| COUPLING LOSS | @150MHz | 72 | 75 | 74 |
| | @450MHz | 76 | 79 | 79 |
| | @900MHz | 80 | 80 | 80 |

triaxial cable is controlled by the separation of the split shields. This approach optimizes the tradeoff between downline attenuation and coupling loss, and they are tightly controlled by the shield width tolerances, as well as dimensional tolerances on both the dielectric core and interlayer. Table 1 above gives values of three of the standard size triaxial designs. The attenuation and coupling loss values are typical of directly mounted conditions. These cables were all mounted directly to the tunnel walls within the New York City transit system, which resulted in easier cable installation and reduced overall cost.

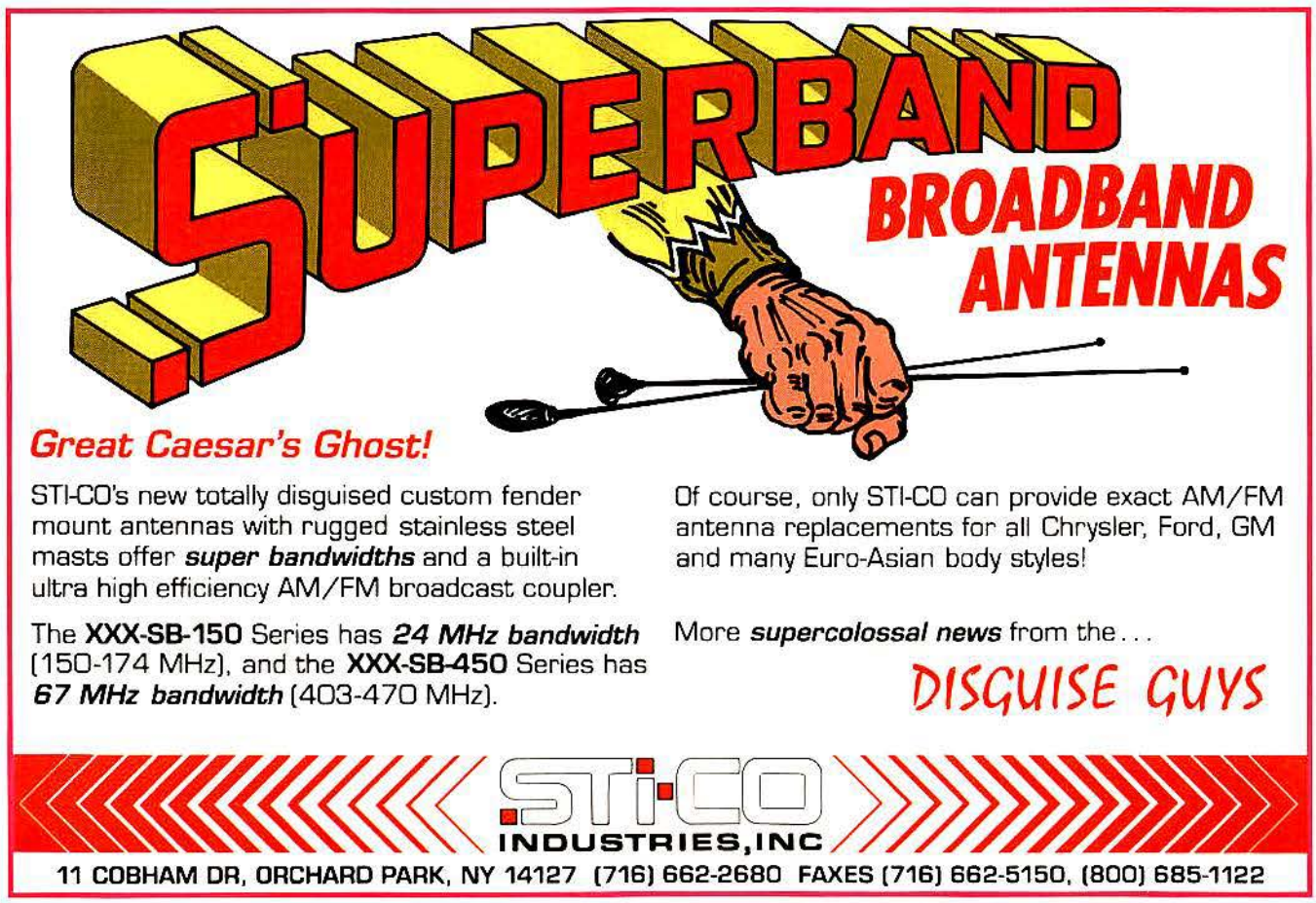
**Mechanical considerations**

In addition to the electrical design performance of these radiating cables, other considerations such as mechanical, physical and environmental issues had to be addressed. The NYCTA required a series of qualification tests to be performed before any cable would be considered for installation within the transit system. Table 2 on page 17 is a partial listing of the environmental, physical and mechanical specifications that the cables were required to meet.

Because of the harsh physical environment that these cables would encounter, additional testing was performed to determine the crush strength of the triaxial designs. Both the corrugated construction and the triaxial design were subjected to a flat plate crush strength test, using the reverse mode on a tensile testing machine. The triaxial cable exhibited increased crush strength to more than twice that of the corrugated copper design. This is primarily due to the tough foamed polyethylene dielectric, along with the protection of the layers of polymeric jacketing material. In addition to the overall higher crush strength, the elastic memory of the materials allowed the triaxial design to return to within one-half ohm of its original impedance, whereas the corrugated construction remained in a crushed state. This increased crush strength and memory may provide the difference in replacing a cable that has been damaged by some outside physical force. The triaxial design is also much more flexible and easier to route than the corrugated copper cable.

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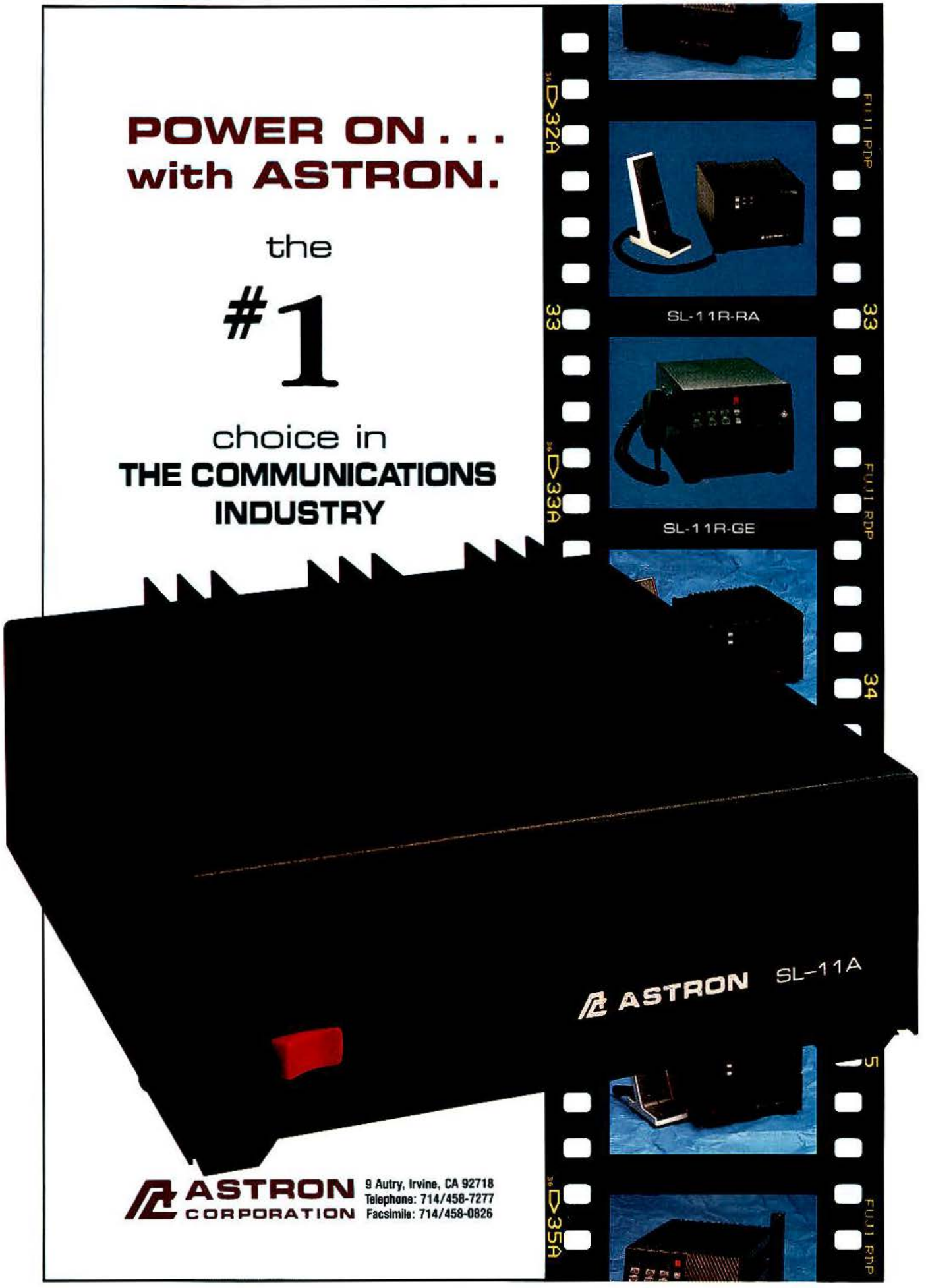
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transit system fires over the years. Death and injury due to toxic products of combustion and smoke have accompanied several of them. As a result, in the last decade, many mass transit systems worldwide have required low-smoke-producing, flame-retardant materials for all products installed in subway tunnels. Events such as the fire at the London Kings Cross Road subway and the tragic loss of 300 lives in the Baku (former Soviet Republic of Azerbaijan) subway fire have led to an increased awareness of the safety of the materials that are specified and used within enclosed areas.

Table 3 on page 17 lists some of the flame performance and products of combustion testing that the triaxial cables meet. With the recent advances in flame-retardant technology and available materials, the triaxial cables are able to meet the required level of flame performance without the need for expensive barrier tapes.

*Because of the varying nature of environments in which radiating cables will be installed, exact electrical performance can be difficult to predict.*

In addition to the flame retardance, all materials used in the construction of this cable are non-halogen. When subjected to a flame source these cables exhibit extremely low levels of smoke generation, toxic emissions and corrosive offgassing.

**System interconnects**

For those sections within the transit system that did not require RF communications, or where system interconnects were needed, shielded low-loss coaxial designs were used. These flame-retardant constructions provide lower downline attenuation because of the non-radiating nature of the designs. Both the low-loss coaxial cables and the triaxial radiating designs can be routed much more easily than corrugated copper cables. The flexibility and non-kinking nature of these cables allows them to be routed and bent into tighter areas, reducing installation time. The interconnect cables are also required to meet all the physical, mechanical, environmental and combustion properties of the radiating cable designs.

Table 2—Physical and mechanical requirements.

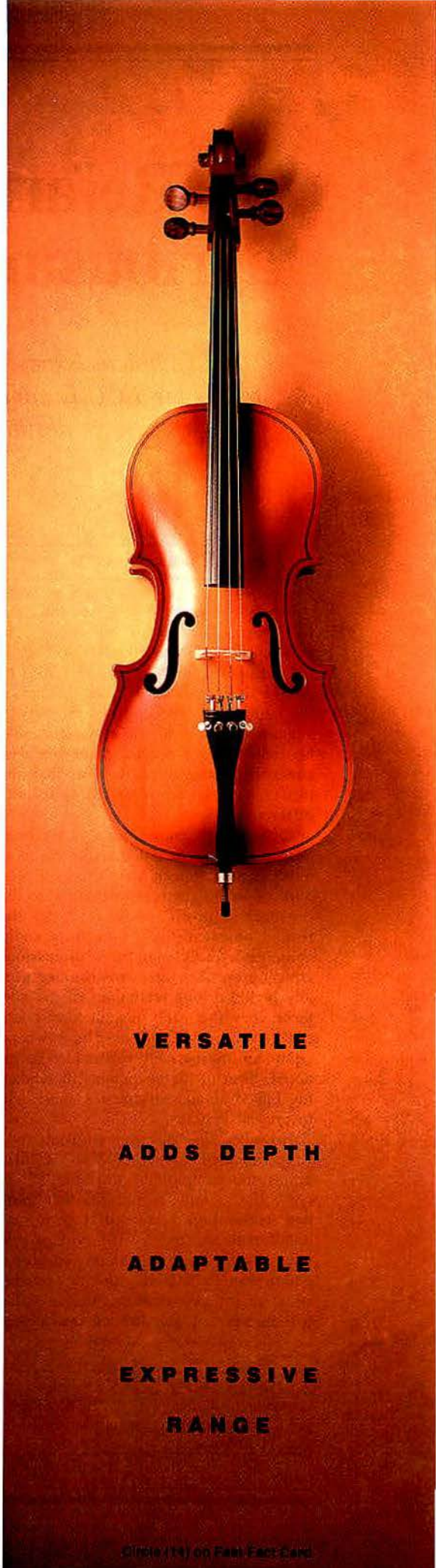
| TEST REQUIREMENTS | TEST METHOD | SPECIFICATION REQUIREMENTS |
|---|---|---|
| PHYSICAL REQUIREMENTS UNAGED<br>TENSILE STR. (MIN. PSI)<br>ELONGATION (MIN. 5%) | ASTM D 412-87 | TEN./ELONG.<br>1000/100% PSI |
| AGING REQUIREMENTS<br>AFTER AIR OVEN FOR 168 HOURS @100°C<br>a. TENSILE STR. (MIN. % OF UNAGED)<br>ELONGATION (MIN. %OF ORIGINAL) | ICEA 5-68-516 | <br><br>60%<br>60% |
| OIL IMMERSION REQUIREMENTS<br>IN ASTM #2 OIL, FOR 4 HOURS AT 70°C<br>B. TENSILE STR. (MIN. % OF UNAGED)<br>ELONGATION (MIN. % OF ORIGINAL) | ASTM D 471-79 | <br><br>60%<br>60% |
| DUROMETER<br>SHORE A | ASTM D 2240-86 | 80 MINIMUM |
| COLD BEND (@ −25°C) | ICEA S-19-81<br>6TH ED., SEPT. 19,<br>PART 6 | PASS |
| WATER ABSORPTION,<br>GRAVIMETRIC METHOD<br>168 HOURS @ 70°C (MG/SQ. IN. MAX) | ASTM D 470-82 | 35 MAX |
| OZONE RESISTANCE TEST | ASTM D 470-82 | PASS |
| TEAR RESISTANCE TEST (MIN) LBS/IN | ASTM D 624-86<br>ASTM D 470-82 | 25<br>25 |

Because of the varying nature of environments in which radiating cables will be installed, exact electrical performance can be difficult to predict. The triaxial cable designs have exhibited that environment affects performance minimally. These triaxial constructions were chosen by the NYCTA for the various benefits and predictability of performance. The installed cables were tested after installation and exhibited high-quality signal levels when subjected to survey test procedures that were required prior to operation of the system-wide police radio system. The ease of connectorizaton, elimination of cable standoffs and the flexibility of these constructions were also benefits provided to the installation contractors.

Over the past three years, the transit police radio communications system has been operating with no defects or downtime.

Table 3. Flammability and combustion requirements.

| TEST REQUIREMENTS | | TEST METHOD | SPECIFICATION REQUIREMENTS |
|---|---|---|---|
| SMOKE INDEX | (MAX) | NES 711 ISSUE | 25 |
| TOXICITY INDEX | (MAX) | NES 713 ISSUE #1<br>JUNE 1979 | 5 |
| ACID GAS EQUIVALENT<br>(HALOGEN CONTENT) | (MAX) %<br>(MAX) % | MIL-C-24643<br>SEPT. 28, 1984 | 0.5<br>0.20 |
| LIMITING OXYGEN INDEX | (MIN) | ASTM D 2863-87 | 32 |
| SMOKE GENERATION<br>FLAMING AVG. DS 4 MIN<br>FLAMING AVG. DM<br>NON-FLAMING AVG. DS 4 MIN.<br>NON-FLAMING AVG. DM | <br>(MAX)<br>(MAX)<br>(MAX)<br>(MAX) | ASTM E 662-83 | <br>75<br>300<br>75<br>350 |
| FLAMMABILITY<br>a. GENERAL (70,000 BTU/HR.) | | IEEE 383-74 | PASS |



# Refarming: The telecom 'agribusiness' of the next decade

*The technical issues affecting the refarming process have been decided, as far as the FCC is concerned, but telecommunications politics are making the destiny of private radio increasingly unsure.*

**By Robert H. Schwaninger Jr.**

Nearly five years have passed since the FCC began the task of "refarming" the radio spectrum below 800MHz, to narrow the channels from their present 15kHz or 25kHz size to a trim 6.25kHz. Although the initial work performed by the agency suggested that everyone's system could be "adjusted" to accommodate the new channel spacing with little more than the turn of a magic screw, the reality is quite different.

Critics of the entire process have been numerous, but none could defeat the enormous pressure put on the FCC by a phalanx of manufacturers salivating at the prospect of profits to be made by the forced obsolescence of existing radio equipment. Early roundtable discussions among proponents of narrowbanding usually included long recitations of the new technology that each manufacturer could bring to the market to make narrowband equipment viable. Physics aside, or ignored, most of the champions of refarming talked about performance equivalent to present systems.

However, any operator who has now "experimented" with 220MHz–222MHz amplitude-companded single-sideband (ACSSB) systems recognizes that these new technologies are still fighting an uphill battle. Although VHF trunking systems benefit more from improved propagation than do 800MHz trunking systems, some of the propagation gains are also lost because of narrowband operations. High-speed data uses are, for the most part, precluded, and getting the darn things to "sound right" has been a major hurdle.

While manufacturers and operators have been wrestling with these problems, the FCC has been engaged in a wrestling match of its own in hammering out issues in PR Docket 92-235. Politics have played a large role in shaping the past decisions and future methods of refarming, and the most recent information demonstrates that politics will still play a part in what private radio looks like in the future.

*Politics have played a large role in shaping the past decisions and future methods of refarming, and they will still play a part in what private radio looks like in the future.*

**Rules in general are 'iffy'**

Although the FCC is far from finished with its transformation of the private radio spectrum, a number of new rules and policies have already been decided. The ones discussed here do not make a complete list (this magazine would wind up looking like the telephone book), but they do indicate a general idea of where private radio is headed.

If you are a licensee of a primary frequency, and you do not change anything about your system, then the refarming rules will have no immediate effect on your operation. You do not have to go out and buy new equipment. In fact, you can replace your present equipment with equally wideband equipment (if it's available). Ultimately, you are likely to want to replace your equipment with narrowband equipment, but you do not have to.

If you are a licensee on a UHF-offset channel, that use can change from low-power to high-power, and primary status has come—although at this writing, the FCC is not yet accepting applications for higher power on UHF-offset channels, despite what some of the application mills have been telling the suckers.

If you add a new channel to your system, or apply for a new frequency at a new location, your request will be subject to new height and power limitations contained within the FCC Rules (maximum effective radiated power [ERP] of 500W). These limitations are similar to those for common carrier operations. If the height and power restrictions do not satisfy your needs, the FCC will accept an engineering exhibit and a justification to get greater coverage from a single site. No waiver is required, but some justification beyond, "Wouldn't it be nice if..." will be required. The exceptions that will require waivers are applicants requesting a service area of greater than 80km and applicants desiring greater height and power from stations sharing frequencies with VHF Public Coast stations.

If you are operating paging facilities on private frequencies allocated for this purpose, your facilities are not subject to the height and power restrictions or, if shared, to auction. So private carrier paging companies are getting a break.

If you are a manufacturer, new applications for type-acceptance of affected radio devices must comply with the first

Schwaninger, MRT's regulatory consultant, is a partner in the Washington, DC, law firm Brown and Schwaninger and is a member of the Radio Club of America.

splits, 12.5kHz for UHF and 7.25kHz for VHF, to receive grant of authority to market new devices within the United States. After 2005, all devices must be capable of operation in 6.25kHz of bandwidth, or less.

If you are a licensee of an ACSSB facility that uses VHF channels—well, your group could hold a meeting in a phone booth. The idea that created this method of operation in the early 1980s has been found wanting, and the FCC is getting rid of that allocation. You *can* continue to operate (albeit with increasing interference problems) until Aug. 1, 2003.

Although the above rules appear to be pretty well set, the evolution is continuing, and some additional fine tuning is likely to occur. The certainties are that the channels will be narrowed; that existing licensees do not have to seek license modifications, except when voluntary; manufacturers of equipment are going to make a bunch of dough; and systems will lose range and quality. The net effect may be that systems will require integrated series of co-channel facilities to perform as well as existing, higher-powered, wider-channel systems.

**Frequency coordinators**

In its original Notice of Proposed Rule Making, the FCC suggested that the number of coordinating entities might be reduced to no more than four, with one being a "Public Safety coordinator" (read, "APCO").* Later, the FCC appeared to be waffling on this idea. Now, the matter is still a curious one. The FCC's latest decision does not appear to put coordinators out of business, but it is likely to reduce the number, in any event.

Stating that competition among coordination services providers is a good thing, the FCC is adopting the LMCC-ITA plan of dividing all of the spectrum below 470MHz into two pools, Private Wireless and Public Safety. The Private Wireless channels would be coordinated among competing coordinators, eliminating interservice sharing costs. The exceptions are power, railroad and central station electrical protection system frequencies, which would still be coordinated by their industry groups for channels that were traditionally allocated only for the specific purposes served by these groups. Other than radio service, the present limitations on specific frequency use (e.g., airport operations, availability only in Puerto Rico) would be largely maintained.

The FCC has stated that it expects the coordinators to create a system whereby each would communicate daily with the others to "coordinate the coordinations." It is not known which entity will mastermind the system to ensure that this virtually real-time exchange of information takes place. What steps the FCC will take to monitor the system's use is also a mystery. But, somehow, the agency believes it will all work.

Chances are that many of the existing coordinating entities will simply drop out of view as the new demands to compete among coordinating entities become reality. Obviously, PCIA and ITA are not going anywhere, and APCO has an almost-permanent charter. UTC is hanging in there, and appears to be getting stronger in some ways, while services like telephone maintenance, taxicab, motion picture and others appear to be fading faster than Nextel's 800MHz Consensus Proposal.

At this point, the FCC has not *suggested* that the actual licensing duties be taken up by the coordinators—with the FCC being more of an official database than an actual processor—but the writing is slowly being scrawled on the wall. In the FCC's Gettysburg, PA, office, an increasing number of independent contractors are doing data entry, and the consumer assistance branch is being scrapped in favor of the agency's new "call center." The Licensing Division is being revamped, modernized and positioned for a new mission that is yet unexplained.

The downsizing of the Gettysburg staff *appears* to be in preparation for the day that all applications will be received electronically. I do not profess to be the most computer-literate guy in town. (In fact, Mr. Brown, my partner, describes my capabilities using words like "throwback" and "technojerk.") Nevertheless, I still find it hard to understand how the FCC plans to collect and associate petitions, waivers, engineering studies and the like (*along with* the electronic forms that will make up applications, thereby reducing the need for staff) unless these duties are outsourced to third parties. If this is what the FCC is planning, where is the Notice of Proposed Rule Making on the subject? I would be somewhat chagrined to discover that the agency has planned this move for years, including making purchasing and hiring decisions based on this

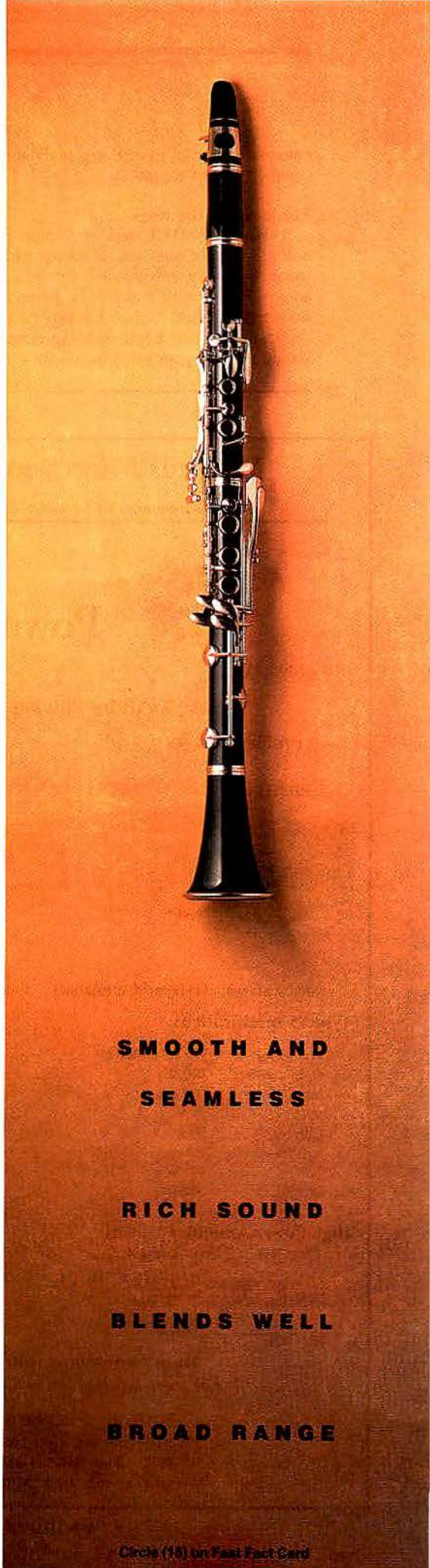
*APCO is Associated Public-Safety Communication Officials–International.

ITA is Industrial Telecommunications Association.

PCIA is Personal Communications Industry Association.

UTC is UTC–The Telecommunications Association (utilities).

LMCC is Land Mobile Telecommunications Council.

Circle (16) on Fast Fact Card

conclusion, prior to seeking mandated comments from the public.

**Thrills from the mills**

Although the FCC has attempted to rationalize the future use of narrowband channels among existing and future licensees, conspicuously absent in the decisions is any effort to halt the actions of applications mills. Logic and experience should tell the agency that the creation of the new channels will ignite a brush fire of speculation activity fueled by the greed of applications mills. It does not take much imagination to hear the pitch now:

"The FCC has created new systems for serving the largest metropolitan areas, and for only $10,000, you can invest in the newest service in the New York City area! Can I put you down for a unit? How about our Gold Circle club for only $20,000 more?!"

I've already gotten wind of one outfit that invested its future in UHF-offset frequencies, and plans to roll it over by getting the suckers' licenses modified to raise the power shown on the useless licenses sold for $7,500-a-whack. Something needs to be done to keep the newly created channels from becoming inventory for scam artists, and the FCC should adopt regulations to combat the problem.

If the adoption of refarming is to be the final solution for private radio channels below 512MHz, the spectrum should be reserved for the entities that the agency claims to be assisting through the creation of additional channels. Perhaps the FCC should adopt a certification program that extends to all application preparers; or should seek greater responsibility from frequency coordinators; or should require evidence of site availability. Whichever method develops a barricade against the abuse of the Commission's application and licensing processes, and protects the American public and legitimate operators from this scandalous behavior, should be made a part of the refarming rules. If not, the likely outcome is a public shame on the agency.

*Something needs to be done to keep the newly created channels from becoming inventory for scam artists.*

**Odds And Ends**

Other points of interest that might help you better understand the changes brought by refarming are:

❑ If you voluntarily change from traditional equipment to narrowband equipment, but no modification is required, the FCC would like for you to notify it of the change by letter or notification via a Form 405A (or the "let us hear from you" rule).

❑ The FCC dumped the idea of creating a new class of 3.125kHz offset frequencies as impractical, and silly, after PCIA's representatives explained to the agency that, really, narrowband and microwave are *not* the same thing.

❑ The FCC has created a few new frequencies for itinerant use. (They did, however, resist referring to the new itinerant channels as "red dot" or "green dot"


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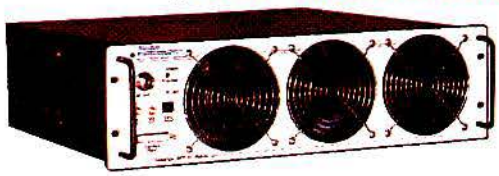
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channels, which would have helped clarify the ruling for companies like Sam's Club.)

❑ There is a new emission designator category for systems authorized to transmit voice, data and fax. The new designator is "W7W" (because "A1A" already runs through Florida).

❑ Stations operating above 800MHz may transmit the station identifier in a digital mode, but stations operating below 800 MHz will still be required to give the call sign in analog. (Smoke signals are still not accepted.)

**Comments, suggestions, ruminations**

If you checked the by-line of this story, you might have expected that some comments would be forthcoming, particularly given the sweeping effect of these regulations. I have made it this far into the piece without really saying my piece—but let's get real. As Tina Turner said, "We never do *nothin'* nice and easy."

To begin, ask these questions: If spectrum scarcity was the motivation for refarming, is that motivation still valid in view of the auctioned spectrum blocks of the last five years? Was spectrum ever scarce in rural areas? In the FCC's earlier roundtable discussions regarding refarming, how many operators participated in those discussions? If narrowband channels are a good idea, why didn't the FCC require cellular, PCS and all of the "newer" services to adopt this approach to spectrum efficiency? And if this idea really smells, why did few alleged "advocates" of operators' rights step forward to defend the current channelization plan?

I'm guessing that most readers can answer all of the above questions. The answers should disturb you, because they speak volumes about the status of our industry and the regulation of the radio spectrum. The answers point to the exclusion of a market segment that relies on private radio spectrum to produce and to transport goods and services that feed, clothe, illuminate, heat and house the American public. How-and-when private radio licensees became an unimportant annoyance to the FCC is not easy to pinpoint, but they have, and refarming is the greatest indicator of this new paradigm.

Spectrum refarming is an idea that was to increase sales for radio equipment manufacturers and to increase the number of channels prior to the FCC's grant of auction authority. In fairness, the spectrum scarcity that existed in 1992 within large cities demanded attention of some kind. However, it is doubtful that a single operator of a single community repeater lobbied for these rules. As further evidence that the FCC itself is not as "gung-ho" about refarming as it once was, consider these two facts: 1) It has taken a long time to get here; and 2) The same idea has *not* been mirrored for use of common carrier channels. Why, and why not?

The answers are that the FCC is touting refarming as a method of increasing the efficient use of private radio channels, while stating that broadband services, like PCS, increase efficient use of the spectrum. The agency staff tells us that spread spectrum will revolutionize the way that people communicate, then that staff creates more discreet narrow channels for private users—channels that will not accommodate this transmission method. The trade publications are filled with new methods for transmitting high speed data,

*How-and-when private radio licensees became an unimportant annoyance to the FCC is not easy to pinpoint. Refarming is the greatest indicator of this new paradigm.*

but the data rate that is possible on narrowband, refarmed spectrum is less than 20% of present capacity.

It does not take a genius (because I don't qualify) to figure out that the telecommunications game is being played in two distinct arenas. The one that promises the big auction dollars is being rewarded with wide bands, flexible use, and incentives to warehouse spectrum for years. The one being played for private spectrum involves users being told to "get small, get slow and keep quiet." The destiny of private radio is being made increasingly unsure through these actions. However, one political fact is becoming obvious. The agency will do little to accommodate any user who didn't shell out at auction for channels.

Is this proper? I, for one (and only one at times), do not think so. Bethlehem Steel should be provided the ability to increase its plants' telecommunications efficiencies through introduction of new technologies, without having to buy a license to serve the entire Northeastern Pennsylvania Region. Federal Express should be able to increase its data capacity on its

*(continued on page 24)*



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*(continued from page 21)*

systems throughout the United States without having to purchase a wideband, nationwide license for billions of dollars. A community repeater operator should not have to force new, narrowband equipment on its tow truck customer just to satisfy the FCC's grand scheme (in which even the agency itself does not completely believe).

Relief for public safety entities might be on the horizon in the form of the reallocation of television channels 60-69. Congress could cobble out some wideband channels for public safety uses that would allow local governments to more efficiently use new technologies. However, little or no relief is in sight for private users. Their chances of obtaining a frequency block, like the blocks sold to commercial carriers, are equal to my chance of being named Reed Hundt's senior advisor. So, private business users will be forced to make do, unless they want to pay high air time rates to commercial carriers to provide service for their internal facilities.

It is ironic that refarming will encourage some of the largest users of telecommunications equipment to opt for more services provided by commercial carriers. The universe of commercial carriers for the equipment manufacturers and suppliers to market to is smaller than the universe of large private users. Therefore, some of the equipment manufacturers that originally supported refarming might ultimately lose market share as they lose direct contact with large equipment purchasers.

The final issue involves exclusivity of use on the new narrower channels. The FCC has not stated whether exclusive use will be allowed or how exclusivity might be earned or purchased. One can imagine a number of ways that exclusive use might come about. I predict that exclusive use will happen, particularly in view of the FCC's desire to reduce the man-hours necessary to resolve disputes among sharing operators. Because the auction price paid per channel (particularly narrow ones) is likely to decrease rapidly, the FCC might not even employ its auction authority in awarding exclusivity.

*The road to refarming has been bumpy. It isn't going to get any smoother, but in Washington the line is 'It isn't perfect, but it's better than auctions.'*

The road to refarming has been bumpy. It isn't going to get any smoother, but in Washington the line appears to be "It isn't perfect, but it's better than auctions." Questions remain, and a lot needs to be discussed before the dust clears. My partner, Curt Brown, will be kicking up some of that dust on the refarming panel at IWCE, Las Vegas [*"How spectrum refarming affects private radio," Tuesday, April 22, at 2:30 p.m.*]. Mr. Brown, Ralph Haller and John Reardon will take any questions you have, but be kind if the answers you are given aren't perfect. As I said, the system isn't perfect yet and probably never will be. What can you expect from a square peg being forced into a round hole?


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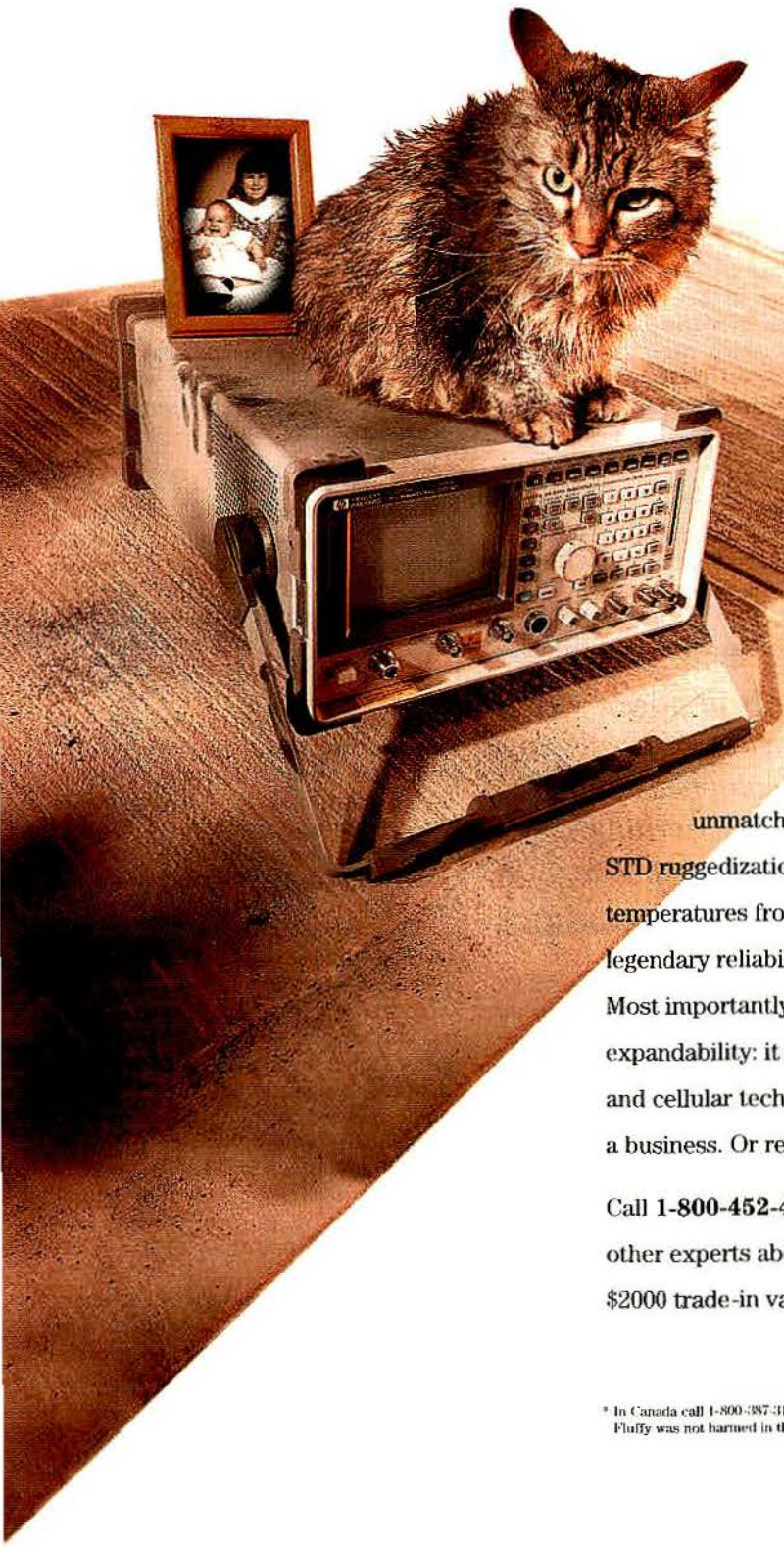
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# Servicing pagers: The password problem

*Are pager passwords necessary? Communication between airtime sellers and the elimination of passwords may be more conducive to business.*

**by David Ludvigson**

A customer came into the shop one day with a succint request.

"Can you hook this up?" He handed me a Bravo Express pager.

"Let me take a look at it," I answered. I took it to the Express programmer, put it in the nest and hit "F3" to read the capcode and frequency information. It was password-protected. I returned it to the customer.

"I'm going to have to look into this one, but I probably can get it hooked up," I said. "When you purchased this pager, you should have received it without any parts missing. This one's missing a resistor, and that prevents me—or any airtime reseller—from programming your pager easily. I have a running feud with an industry that allows the seller to 'own' a customer's property."

He left the pager with me after agreeing on a price.

I went into the shielded room, better known as the "tin-foil tomb," and pulled the Express apart. R6 was missing, a 56kΩ "chip" resistor on the logic board. The sales force of the previous dealership has probably programmed the pager, included a password and then removed the resistor. I was frustrated—I had no way to get back to them about this customer's pager bill.

Replacing the resistor took a few minutes. Then I went over to the computer, pulled up Ultratek's Pagersaver application and overwrote the password. I checked the BREXPPS files and made sure I had removed the password. The procedure doesn't always work at first, and several tries might be needed. I was lucky—this time.

A few hours later, another customer brought a Bravo Plus into the shop. Same problem, same cure—only this time R26 was missing, another 56kΩ "chip" resistor on the logic board.

I went back to the computer program, performed an overwrite of the data and put the assembled pager back into the programmer nest to read it. Checking BRAVOPPS, I found that the pager had been erased. Another capcode, another pager, another day....

Ludvigson is a technician in Houston.

### Forward bias

The R6 chip in the Bravo Express, or R26 in the Bravo Plus, forward-biases the "READ" line in either pager. This puts a low current and high voltage (3V) on the line. If this voltage is not present, the program will not be able to read the existing information in the pager, and programming the Plus or the Express will not be possible. Usually, the LED on the programming interface will not illuminate, regardless of how much you argue with the interconnecting pins.

*Passwords in pagers are a crude means of preventing an unequipped retailer from overwriting a previous capcode.*

### Line cutting

In the Bravo, there is really no true "password protection," but some enterprising person discovered that by setting the "CLOCK," (or "STROBE") line, the pager would not be able to communicate with the Bravo programmer. The pager is programmed, then the CLOCK line is cut.

Such problems are easily diagnosed. The programmer just sits there, prompting "insert pager," regardless of how many times you've inserted the thing. At least I could read the old capcode and deduce who the airtime supplier was from the frequency.

The solution is to scrape away the ends of the break, tin them slightly with solder and "jump" the gap with a single strand of multiconductor zip-cord.

### Churn and connivance

Any thrifty customer will shop around for the lowest price for airtime. Unfortunately, the customer will often "forget" to call a previous airtime supplier to inform it of the decision to discontinue service. Passwords in pagers are a crude means of preventing an unequipped retailer from overwriting a previous capcode.

Unfortunately, I cannot count the times when an unscrupulous customer has left an account "hanging," wandering off after being activated for a single month. Resellers cannot take the time to *completely* research a capcode. They certainly cannot take *any* step toward checking the capcode if it is unavailable because of password or circuit destruction.

Some politicians and pundits have proclaimed the need for a national registry of pager numbers, capcodes, airtime suppliers, customer names and resellers. The reality that is overlooked is that pagers are traded, bought and sold on every street corner in every large city. Tracking such a commodity would take the time and effort of at least six angels or a massive, invasive bureaucracy. Statewide or national registry of personal property like automobiles is one thing, but a $100 pager? Get real.

No, some other form of programming a pager is far more realistic. Avoid the use of passwords, leave the information available to other resellers and let them contact the previous reseller or airtime supplier. Passwords in a pager are unnecessary and prevent any legitimate business from fairly obtaining late payment if due. The use of passwords can be self-defeating.

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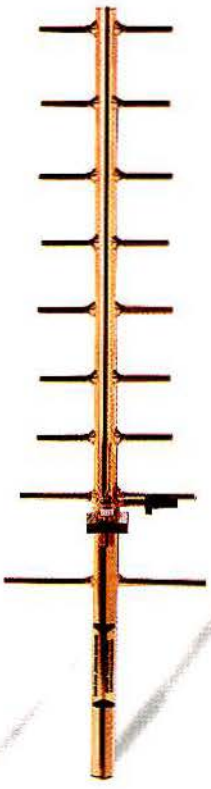
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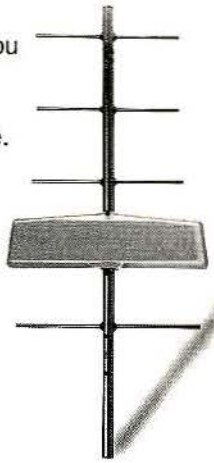
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# Battery technologies for critical applications

*Various battery chemistries are evaluated not only on the merit of long talk-time but also with respect to operational costs, exercise requirements, self-discharge and load characteristics.*

**By Isidor Buchmann**

For many years, nickel-cadmium (NiCd) was the only practical battery for portable radios, cellphones, laptop computers and video cameras. The need for increased talk-time demanded the development of alternative chemistries. As a result, new battery types have emerged that provide twice the energy densities as the standard NiCd.

Will the new generation batteries eventually replace the classic NiCd? That depends on the position the NiCd will hold in the future and the pros and cons of alternative chemistries. Various battery chemistries have been evaluated not only on the merit of long talk-time but also with respect to operational costs, exercise requirements, self-discharge and load characteristics.

▶ *Nickel-cadmium* — Available since early 1950, the NiCd continues as the most commonly used battery today. It provides good load characteristics, and it is economically priced, simple to use and forgiving when abused. The main applications are portable radios, cellular phones, video cameras, power tools and some biomedical instruments.

The NiCd has medium energy density and needs monthly exercise to prevent memory (as in crystalline formation). With proper care, the NiCd provides an impressive 1,500 discharge-charge cycles. At four cents per cycle, the NiCd is the most economical battery available.

▶ *Nickel-metal hydride (NiMH)* — Introduced in the 1970s but not commercially available until the early 1990s, the NiMH offers 30% higher energy density and has fewer toxic metals than the NiCd. The main applications are cellular phones and laptop computers where high energy is important, regular exercising is not practical and cost is secondary.

The NiMH is more expensive and does not have the same proven track record as the NiCd. The charge algorithm is more complex and requires a longer charging time than the NiCd. In addition, the self-discharge is higher and the load characteristics are less favorable than that of the NiCd. Memory is not as prevalent as with the NiCd, although it is recommended to exercise the NiMH once every three months. The expected cycle count is 500 at a rather high 16 cents per cycle.

▶ *Sealed lead-acid (SLA)* — Known in the automotive industry as the *flooded* type, the SLA has existed in various formats since the 1960s. It is commonly used where bulk power is required, weight is not critical and cost must be kept low. Applications include wheelchairs, uninterruptible power supply (UPS) units, emergency lighting and some portable biomedical equipment.

The SLA has a low energy density and must be kept in a charged condition at all times. There is no memory effect, but the SLA should receive a topping-charge every few months to maintain good charge

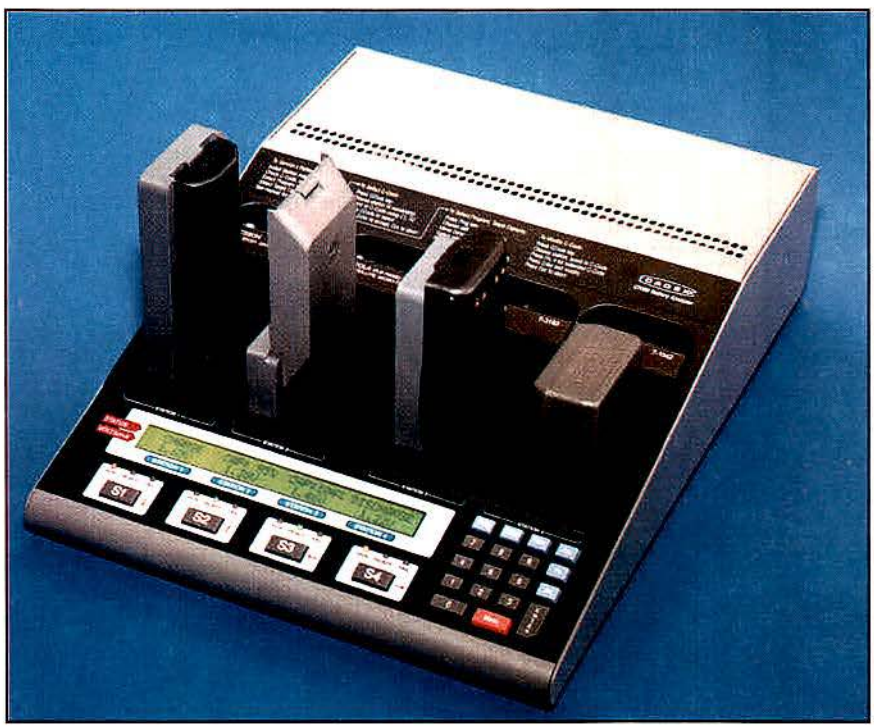
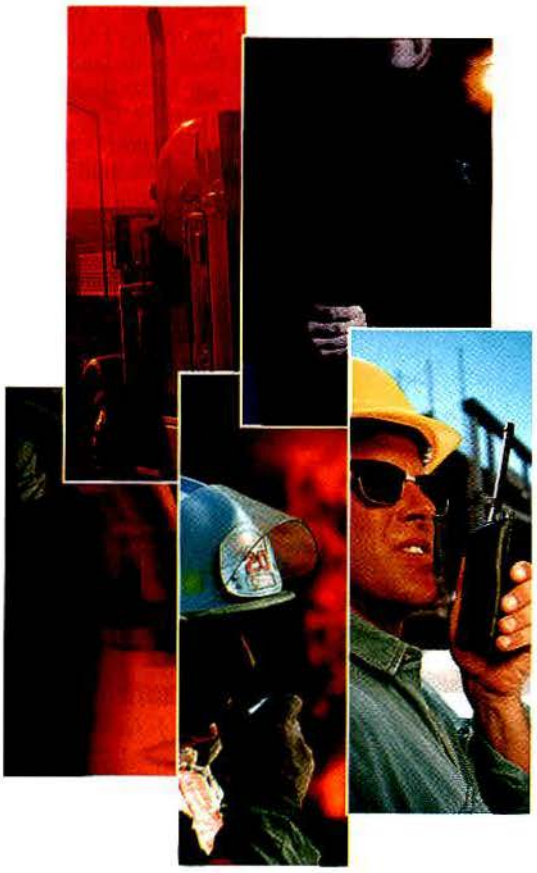


**Photo 1. Configured battery cups in this analyzer accommodate all common batteries; uncommon batteries interface through smart cables. An optional printer generates service reports.**

Buchmann is founder and president of Cadex Electronics, Burnaby, British Columbia, Canada.

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acceptance. Unlike the NiCd and NiMH, the SLA cannot be fast-charged. A typical charge takes about 10 hours. The load characteristic is moderate, but the self-discharge is low. The expected cycle count is between 200 and 300 at a cost of 10 cents per cycle.

▶ *Lithium-ion (Li-ion)* — New on the market and only available in limited supply, the Li-ion provides an energy density that is twice that of the NiCd and has the lowest self-discharge among rechargeable batteries. There are two basic types of Li-ion: the *Sony*, with an end-of-discharge threshold of 2.5V on a linear discharge curve, and the *Sanyo, Matsushita, Toshiba, Hitachi* and *Moltcel* that discharge to 3V on the preferred flatter curve (similar to NiCd with sharp knee point). For safety and longevity, each battery pack must contain a control circuit to limit the voltage peak during charge and voltage drop on discharge. Additional safety measures include current-limiting, temperature-sensing and high-pressure shut-off. Typical applications are cellphones, laptop computers and video cameras. The Li-ion contains no lithium metal and is safe if used as directed.

The Li-ion has no memory, its charge time is three to six hours, and the expected cycle count is 300–500. The load characteristic is better than that of the NiMH and SLA but not as good as the NiCd. Because of the high battery price, the operational cost is an astonishing 25 cents per cycle. With better manufacturing techniques and the replacement of cobalt with less expensive materials, the price of the Li-ion is expected to drop by half by 2000.

**Battery maintenance**

A difficulty all battery users face is not knowing when the battery power runs out. For the first year while the equipment is new, everything seems to work fine. As the battery ages, a gradual loss of charge acceptance occurs without the user knowing. Although fully charged, the battery eventually regresses to a point where it may hold less than half of its original capacity, resulting in unexpected down time.

*All nickel-based rechargeable batteries are affected by "memory" to varying degrees. This phenomenon also applies to NiMH cells, but to a lesser extent than NiCds.*

All nickel-based rechargeable batteries are affected by "memory" to varying degrees. This phenomenon also applies to NiMH cells, but to a lesser extent than NiCds. Memory is a buildup of crystalline formation on the cell plates that robs the battery of its capacity. It occurs most commonly when the battery is left in the charger for days or is repeatedly recharged without a periodic full discharge. The capacity loss caused by memory is, to a certain extent, reversible.

To regain lost capacity and to keep a battery fleet in peak performance, nickel-based batteries must be discharged periodically to 1V per cell, a procedure also known as *exercise*. The recommended




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frequency of exercising the NiCd is once per month, whereas the NiMH should be done once every three months. Because of its shorter cycle life, it is not recommended to overexercise the NiMH.

If no exercise is applied for several months, the crystalline formations ingrain themselves, making it more difficult to dissolve them. In such a case, exercise is no longer effective in restoring a battery, and *recondition* is required. Recondition is a slow, deep discharge that is applied below the 1V per cell threshold. Lab tests have shown that a NiCd cell should be discharged to at least 0.6V to dissolve the more resistant crystalline buildup effectively. When applying recondition, the recondition current must be kept low to prevent cell-reversal, a state in which the cell polarity reverses, rendering it defective.

As previously mentioned, the NiCd should provide a service life that is substantially longer than that of the NiMH. If this cannot be achieved, either the charger is unsuitable, the cells are of inferior quality or the NiCd battery is not being properly exercised. Using good-quality cells and a suitable charge algorithm, NiCd batteries tested in our laboratory consistently provide more than 4,000 full discharge-charge cycles. Similar results should be achievable in the field.

**Battery analyzers**

During the past few years, battery analyzer technology has advanced significantly. No longer are we limited to analog units with fixed charge-discharge currents and programs that only apply one or two discharge-charge cycles.

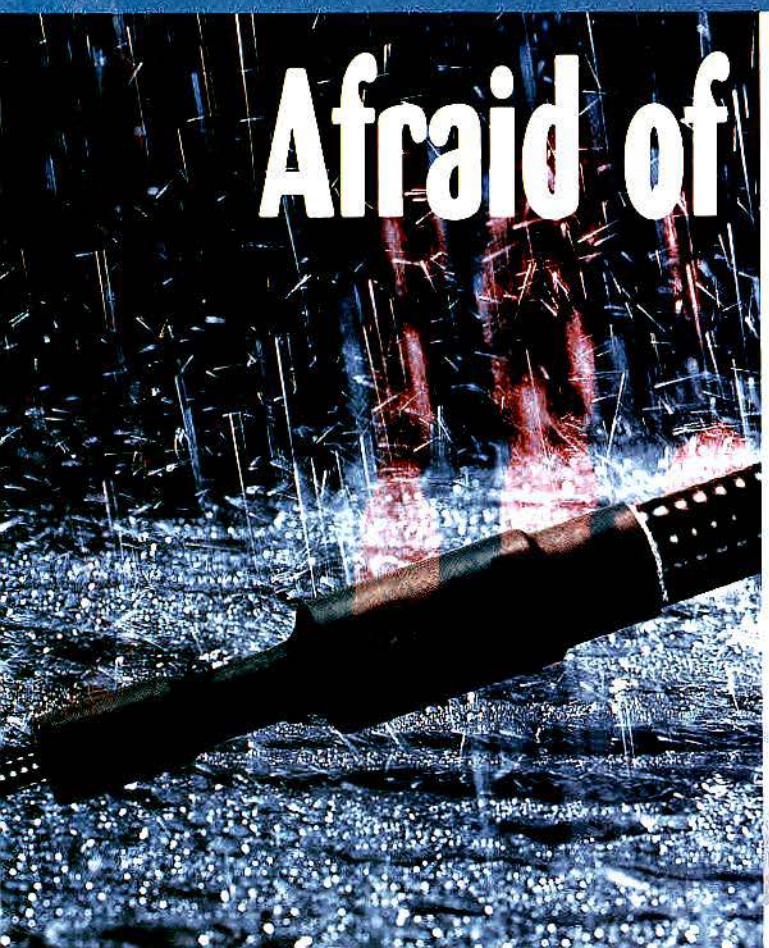
One particular programmable battery analyzer is capable of servicing NiCd, NiMH, SLA and Li-ion batteries simultaneously. The batteries are tested against preset voltage and current ratings that can be entered though the keypad. Configured battery cups accommodate all common batteries; uncommon batteries interface through smart cables. An optional printer generates battery service reports and labels. (See Photo 1 on page 28.)

Another, more advanced battery analyzer evaluates the condition of each battery and implements the appropriate service to restore its performance. A recondition cycle is applied automatically if a user-selected capacity level cannot be reached. Battery chemistry, voltage and current rates are user-programmable. These characteristics are stored in interchangeable cups and configure the analyzer to the correct function when installed. Each cup holds as many as 10 battery codes to service all battery types within a product family, eliminating the need to reprogram for each battery type. Battery-specific cups are available for all common batteries; user-programmable smart cables service batteries for which no cup is on hand.

Because the service is performed against preset characteristics, the batteries are charged and discharged under true field conditions, a feature that provides accurate test results as well as fast service. Batteries with shorted, mismatched or "soft" cells are identified in minutes, their deficiencies are displayed and, if necessary, the service is halted. The derived battery capacities are organized into residual and final capacities. Problems, such as insufficient capacity reserve at the end of field use, are easily identified to allow necessary corrections.

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analyzer must feature multiple, redundant, charge-termination algorithms to ensure that the batteries are charged quickly and safely and without overheating. Without this provision, battery packs with shorted or mismatched cells may sustain damage caused by overcharge. User-selectable programs address the different battery needs and include a *prime* mode to prepare a new battery for field use; an *auto* mode to recondition batteries unable to reach a user-set target capacity; and a *custom* mode to allow the operator to set a sequence of unique cycle modes composed of charge, discharge, recondition, trickle charge or any combination thereof, including rest periods and repeats.

An important feature of an analyzer is easy operation, a quality that is especially useful when confronted with servicing an ever-increasing fleet of different battery types. It is more convenient to read the test results in percentage of the rated capacity rather than in milliampere hours (mAh) because this frees the operator from memorizing the ratings of each battery tested. In addition, simple "pass-fail" lights help to distinguish good batteries from unserviceable ones at a glance.

Analyzers capable of printing service reports and battery labels simplify the task of keeping track of the batteries serviced. By attaching the label to the batteries, the user is informed of the battery's history and pending maintenance. To keep current with the latest battery developments, a battery analyzer should allow firmware upgrades to enable servicing new chemistries when introduced.

Advanced battery analyzers are capable of connecting to a computer to form a network servicing more than 100 batteries simultaneously. Battery test results are fed into a database from which inventory, service reports and graphs are generated. User-friendly software allows remote controlling of the analyzers through a central computer keyboard, including the downloading of firmware into the analyzer's flash memory to upgrade existing firmware, or to custom-program an analyzer for a special function. The battery ID number and characteristics can be printed on bar code labels to be attached to the batteries. By swiping the bar code with a wand, the battery is identified, and the analyzer is automatically configured for the correct battery parameters.

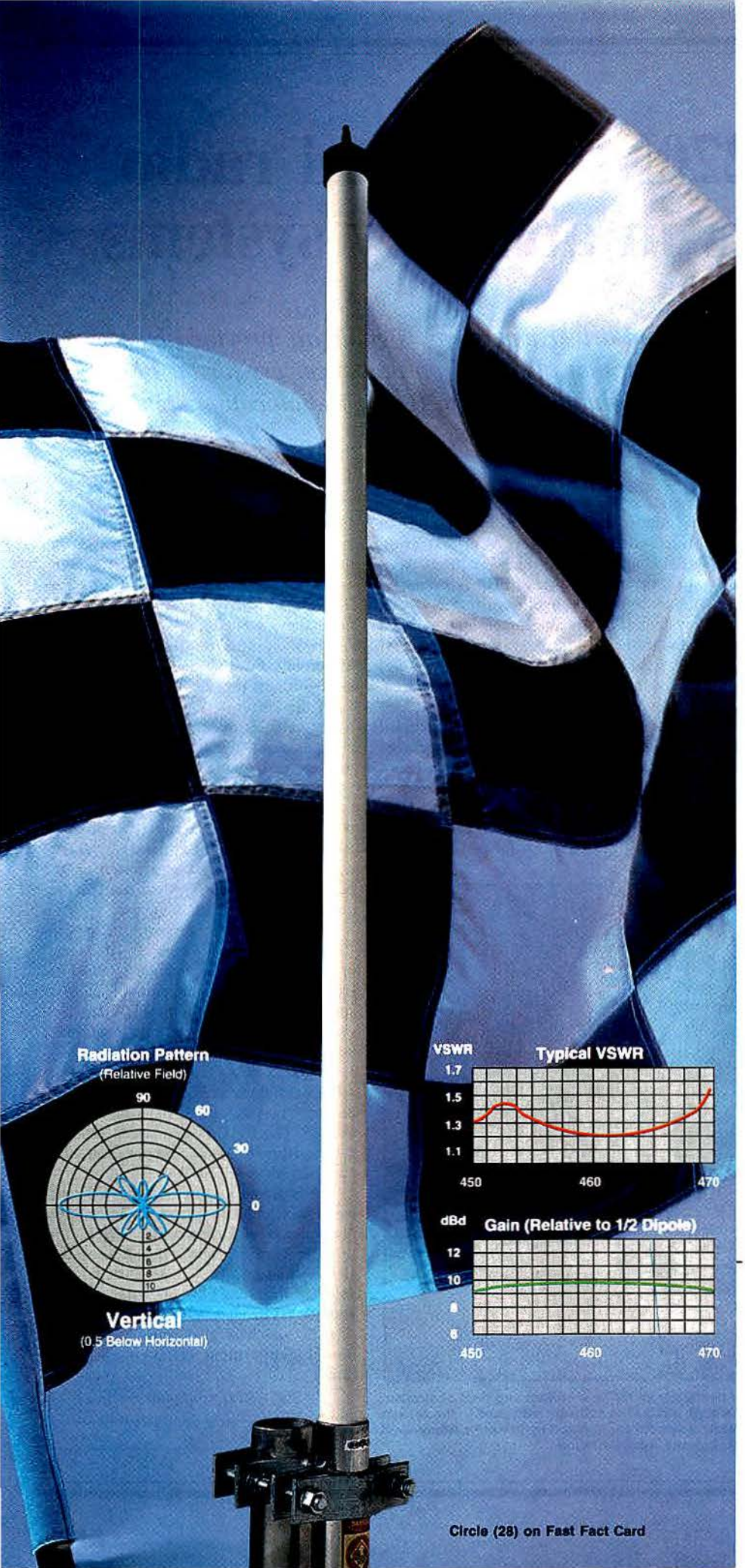
*By swiping the bar code with a wand, the battery is identified, and the analyzer is automatically configured...*

**Summary**

Battery performance has improved significantly during the past few years. In addition, the need for regular exercise to keep the batteries in good condition has been reduced or eliminated altogether with some chemistries. Interestingly, though, the one battery chemistry that offers the best load characteristics with the lowest operational cost is also the one with the highest exercise requirement. With today's advanced battery analyzers, the task of providing quality battery maintenance has been much simplified.




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# Using 220MHz digital radio networks in advisory systems

*Vehicle polling, tracking and driver emergency signals are provided by a 220MHz RF link in a system that also incorporates receivers for an FM subcarrier and for Global Positioning System (GPS) radiolocation signals.*

**by D.A. Keckler**

While millions of tourists and residents wended their way through metropolitan Atlanta last summer during the Olympics, 200 of the vehicles moving among them were being used to develop technology to make navigating the roadways more efficient for fleet and consumer vehicles.

The vehicles were part of a field operational test of the Atlanta Driver Advisory System (ADAS), a real-time, in-vehicle system combining a 220MHz RF link, a 72.2kHz FM subcarrier and Global Positioning System (GPS) location signals, as shown in Figure 1 on page 38.

Funded by a $7.2 million grant from the Federal Highway Administration (FHWA), the test, which ran from April to December, is part of FHWA's national effort to develop intelligent transportation system (ITS) technologies and national standards for those systems. The next phase, model deployment systems, is being carried out in the New York area, Phoenix, San Antonio and Seattle.

Partners in the Atlanta project included the FHWA, the Georgia Department of Transportation, Oak Ridge National Laboratory, Federal Express, TRW Transportation and Systems, Georgia Tech Research Institute, Georgia Institute of Technology, Clark Atlanta University, Concord Associates and Scientific Atlanta. Contributions from the partners in the project brought funding for the cooperative agreement to a total of $9.1 million. Scientific Atlanta coordinated the project and created a new 220MHz digital radio system for the Atlanta test. Motorola's Position and Navigation Systems Business provided the GPS receivers.

Of the 200 test vehicles, 100 were delivery vehicles operating for Federal Express, making the test results applicable to fleet management as well as private vehicle operation.

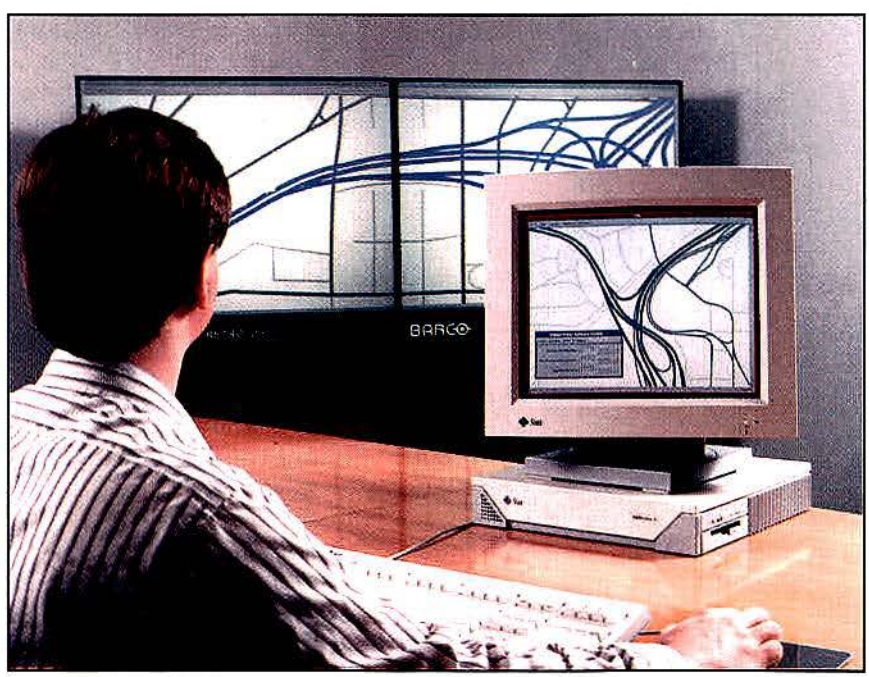
"The 220MHz two-way radio system, we designed from scratch," said Will Blakeley, ADAS project manager for Scientific Atlanta. "That was based on the desires of the FHWA to try out that frequency band for their own use."

As part of the refarming process *(see "Refarming: The Telecom 'Agribusiness' of the Next Decade," page 18)*, the FCC has allocated 10 channel pairs of 220MHz spectrum nationwide to the FHWA, which opens the opportunity for a national driver advisory network.

The other major radio component of the ADAS system is an FM subcarrier, or subcarrier traffic information channel (STIC). The STIC design was created by the non-profit Mitre Corporation on a commission from FHWA.

The National Radio Standards Committee (a joint industry effort of the National Association of Broadcasters [NAB] and the Electronics Industries Association [EIA]) has completed an independent study of different FM subcarrier systems, and the STIC product developed for the ADAS (which is also being used in the model deployment cities) was highly rated.

*(text continues on page 42)*




**Mapping software developed by Scientific Atlanta allows traffic monitors and fleet controllers to follow individual vehicles as they travel through a city. The software was used in the Atlanta Driver Advisory System (ADAS), a radio-controlled system coordinated by Scientific Atlanta and receiving majority funding from the Federal Highway Administration.**

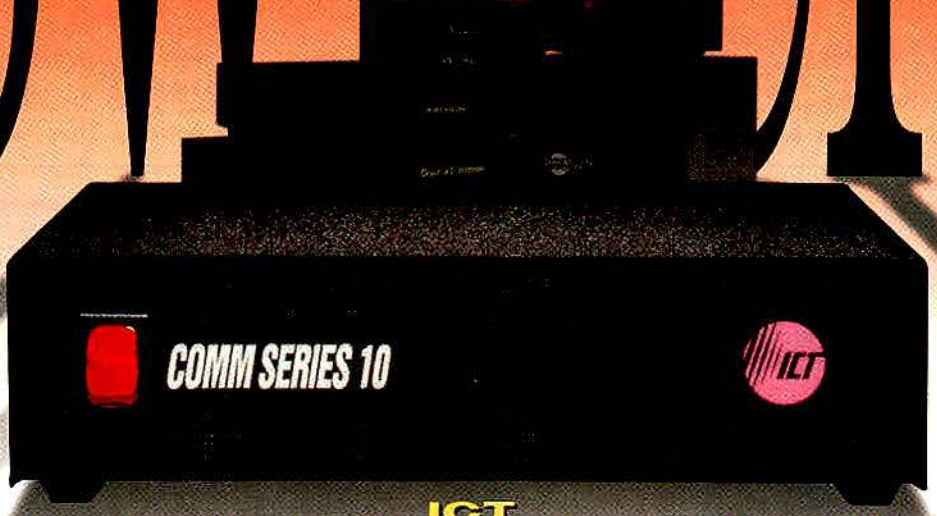
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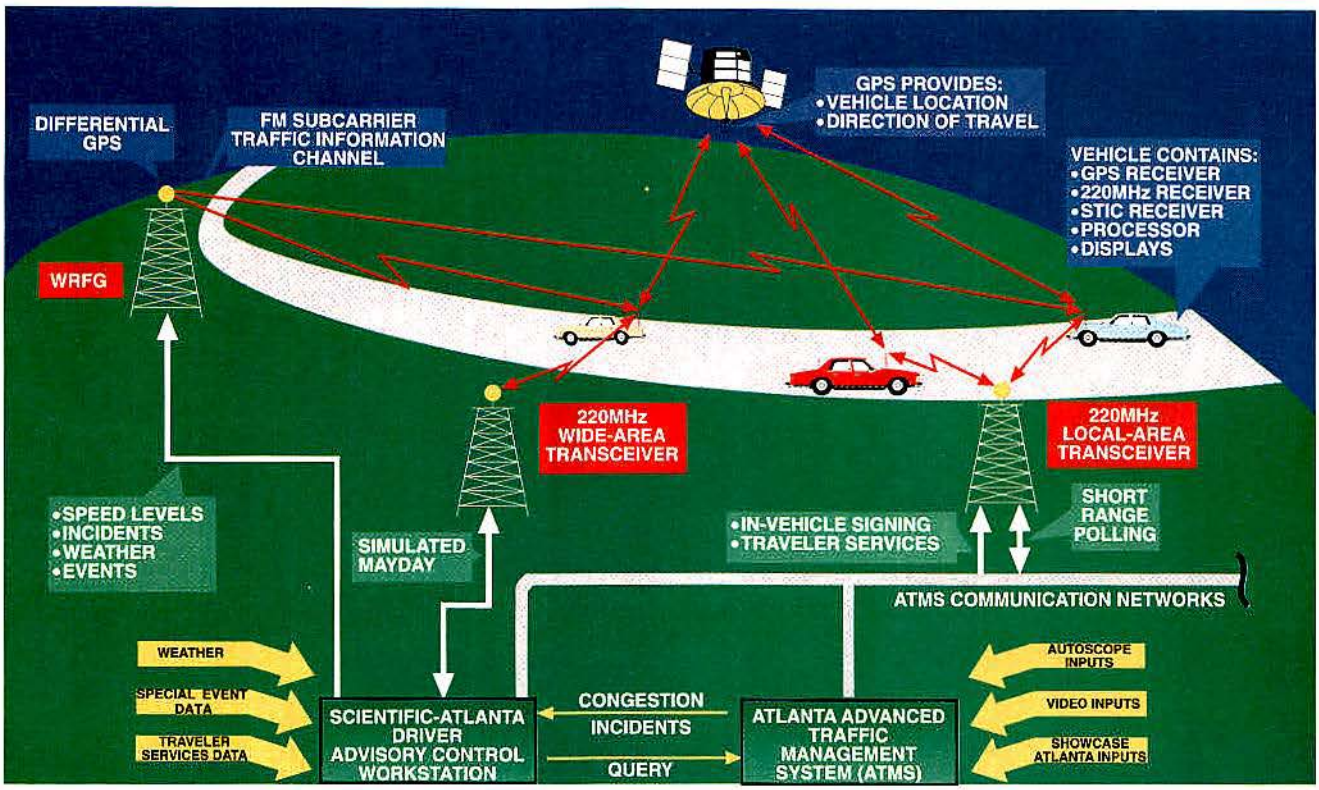



**Figure 1. The field operational test setup for the Atlanta Driver Advisory System combines FM, 220MHz, and GPS into one information system.**


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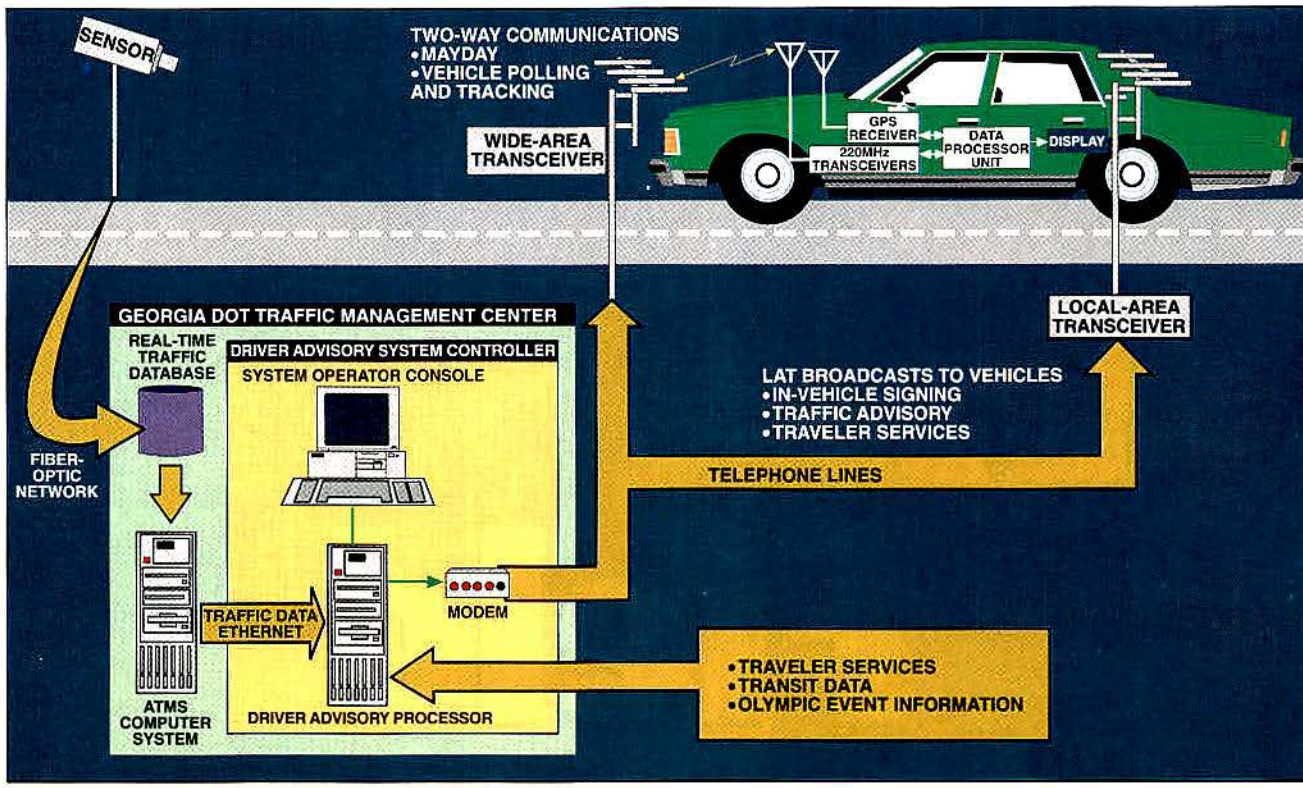



**Figure 2. Components of the 220MHz digital radio network for the driver advisory system.**


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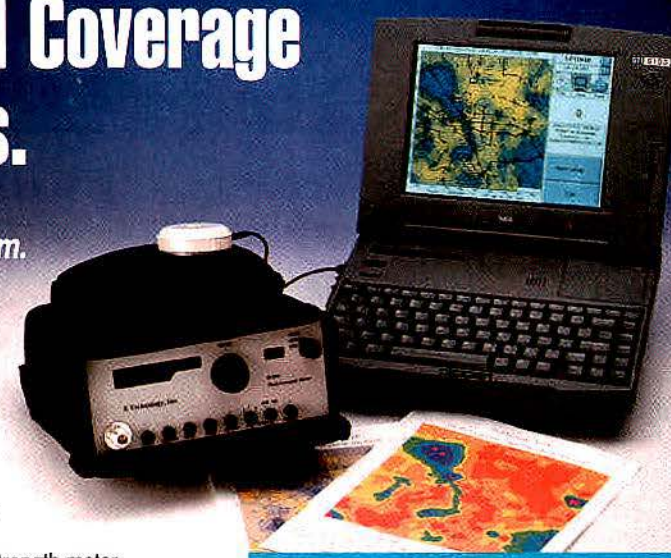
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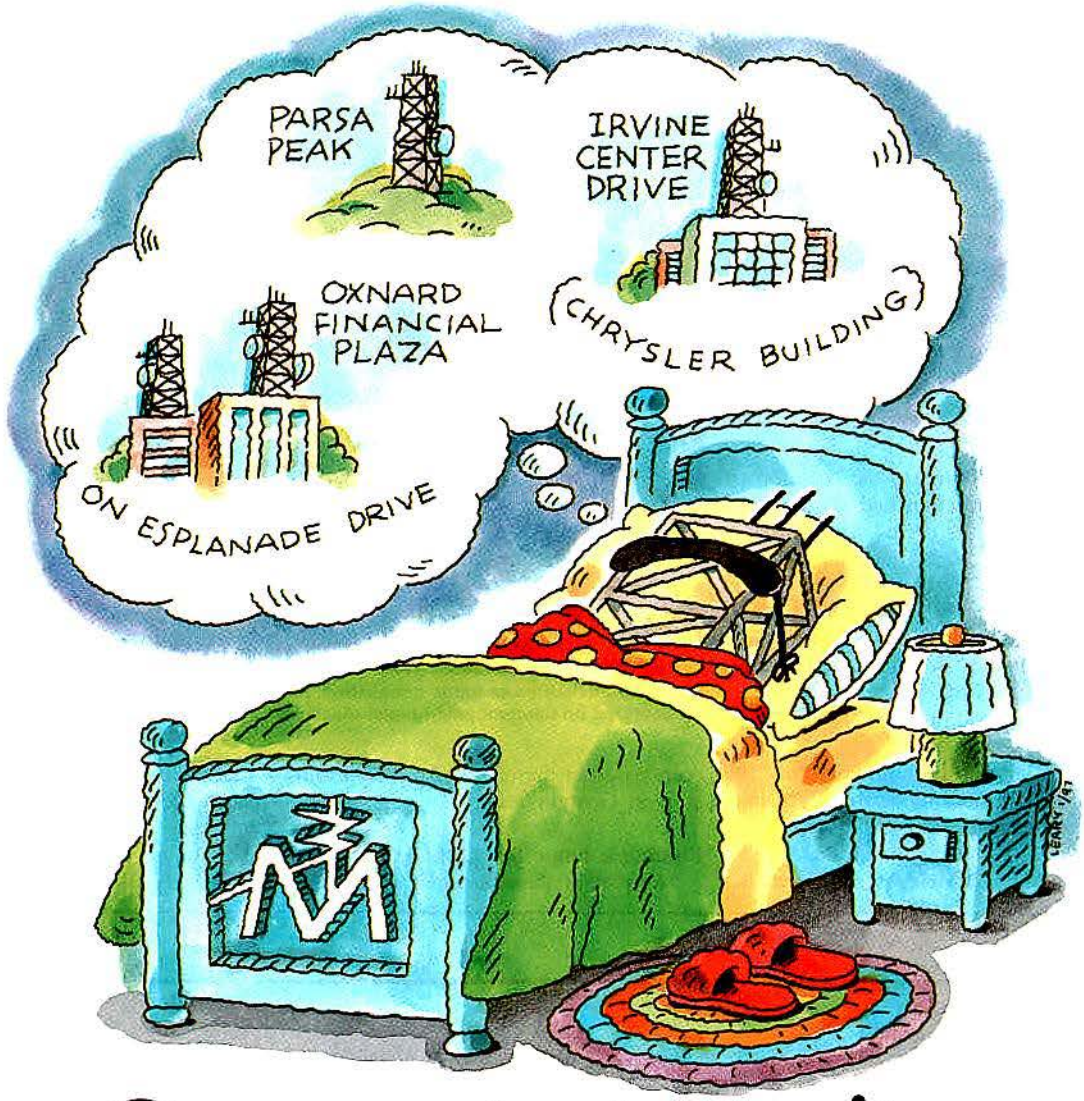
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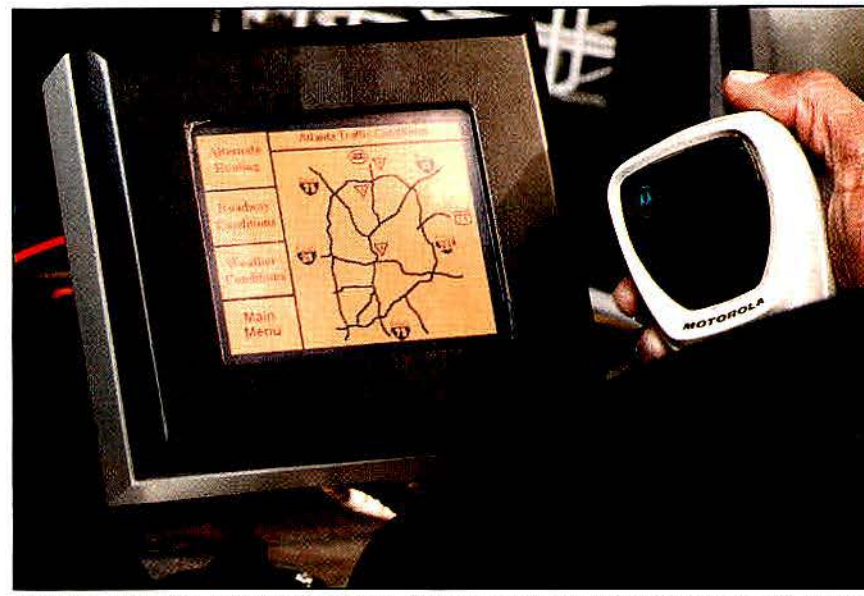
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"We expected the FM subcarrier to perform very well in a mobile environment, Blakeley said. "The waveform is designed very robustly, almost like a Department of Defense secure communications link. It's got all the various types of forward-error correction to combat multipath fading that you see in a mobile environment. I guess we were pleasantly surprised at just how well it did perform. We got excellent coverage all over the city, and in this study that the NRSC performed, there was just no comparison between STIC and competitors."

"They [Mitre] designed the waveform, forward-error correction and all the different aspects of the digital wireless data link," Blakeley said. "That was done in the interests of the FHWA to create an open, non-proprietary standard. We [Scientific Atlanta] then took that design, and we implemented it—we built actual hardware, and that's what we're offering now in San Antonio, Phoenix, Boston and elsewhere."

The model deployment systems in Phoenix and San Antonio are only using the FM subcarrier, not the 220MHz two-way link. A final evaluation of the ADAS test, including 220MHz, is scheduled to be released at the end of April by evaluators at Georgia Tech.

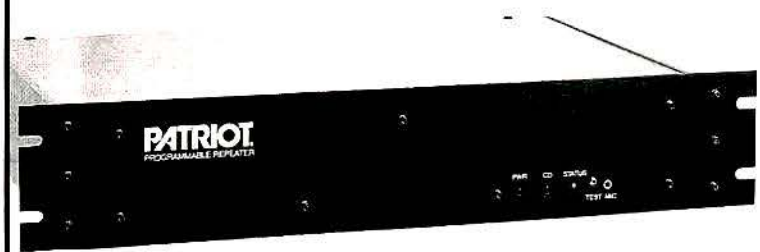


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### Finding a home for 220MHz

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their technology deemed as the standard," Blakeley said. Advocates can be found for 220MHz cellular, CDPD, satellite, 800MHz and 900MHz systems.

"There just hasn't been yet, in the national architecture, a slot set aside that says okay, 220MHz is going to be used for *this* function," Blakeley said.

Scientific Atlanta has proposed the 220MHz radio system it designed for the FHWA as a North American standard for ITS two-way communications use, using the allocated channels, as well as commercial channels. The system created for the ADAS includes short-range, roadside-to-vehicle transceivers, as well as long-range transceivers, as shown in Figure 2 on page 40. The short-range (local area) transceivers deliver in-vehicle signing, roadway conditions and traveler services information. The long-range (wide-area) system poll tests vehicles and provides a two-way "mayday" notification for vehicle distress. Polling information is used to estimate congestion levels along major roadways.

The 90W base station transmits at 220.0025MHz–220.9975MHz; the mobile at 221.0025MHz–221.9975MHz. Channel spacing of 5kHz is used, with modulation to meet FCC Part 90 requirements for 5kHz narrowband channels. Narrowband data rates were designed at 5,200bps uncoded and 2,880bps user data rate using standard error-correction coding. The full-duplex base station supports multiple transmit and receive channels. The half-duplex, 20W mobile unit locks to the base station signal for frequency stability and has the optional capability to receive two signals simultaneously. Receiver sensitivity of the mobile is −110dBm for 0.01 bit-error rate (BER), uncoded, in a static environment and −95dBm for 0.01 BER in a mobile fading environment.

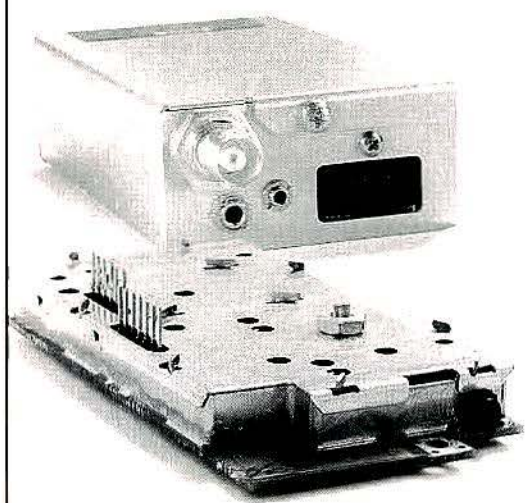
Blakeley said both performance and access are points supporting the proposed standard. "The real savings to the state DOTs or the federal government is that if this is going to be a function provided by a federal or state agency, they don't have to buy any license fees; there are no usage fees; there are no message transaction fees, because they own that spectrum—that's a huge advantage."

The FHWA is trying to get some compatibility among the cities that were selected for the model deployment. Standardization is needed so that a radio receiver in San Antonio would work just as well as in Phoenix. Accordingly, the systems developers are using non-proprietary, open architectures.

For any successful nationwide, or North American, deployment of ITS, standardization will be essential to provide vehicles with a ubiquitous system.

"We're working very closely with the National Architecture Committee for ITS, that's headed by FHWA and major contractors," Blakeley said. "The one we've been speaking with most is Rockwell. They're trying to establish a national architecture, so this could become ubiquitous in the future. If someone doesn't establish standards like that, I don't see that happening."

In addition to fleet vehicles, applications for automobiles are gaining the attention of automotive electronics original equipment manufacturers (OEMs) such as Rockwell, Alpine, Siemens, Zexel and Philips. In-vehicle navigation systems are being tested in Hertz and Avis rental vehicles to give destination directions. Radio links will add the advantages of combining the GPS map data base with current traffic and detour information to compute a route based both on shortest distance and shortest time.

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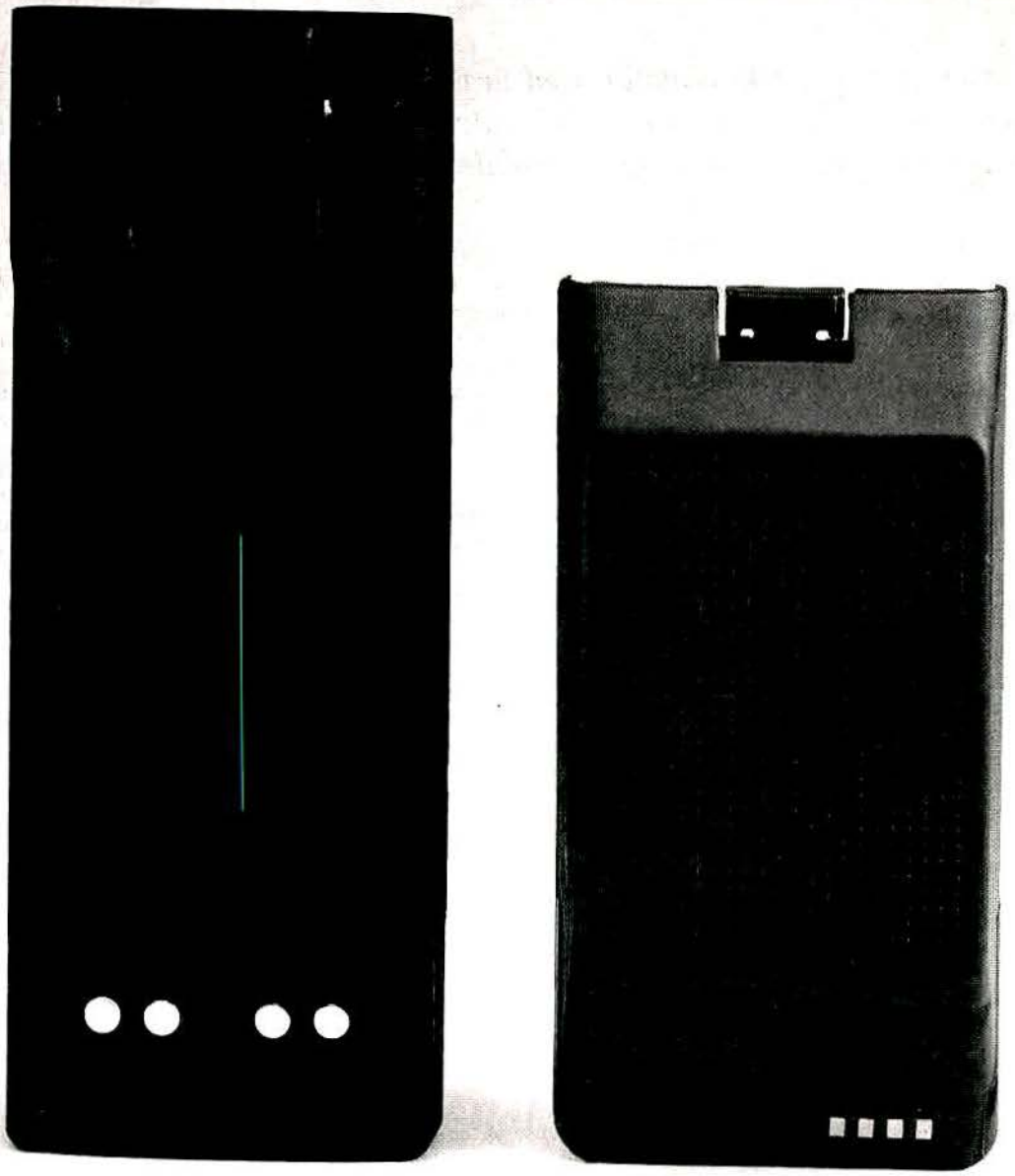
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# Mobile data system serves Australian cable TV operator

*The fleet of 1,500 vehicles used in the installation of a fiber-optic cable backbone made nationwide communication crucial. A country-wide trunked radio system and a fast, reliable, mobile data system were essential components.*

**By William J. Scott**

In 1995, one of the two largest cable TV (CATV) service providers in Australia, Optus Vision, was faced with the enormous task of installing backbone fiber-optic cable to serve hubs in the country's largest cities and then to route cables to customer premises. A fleet of 1,500 vehicles was required.

Communication with this massive fleet would require a country-wide trunked radio system, order takers and dispatchers in each large geographic area, trunked radios in each vehicle and a fast, reliable mobile data system to facilitate the transmission of a tremendous number of messages every day from the dispatcher to each fleet vehicle.

In the past, companies would have tried to communicate via dispatch voice radio. This method has a number of problems:

1. Voice messages require a lot of airtime.
2. Voice messages can easily be misconstrued, possibly resulting in the recipient taking an incorrect action.
3. The number of radio channels necessary to provide capacity for 1,500 would require a prohibitively expensive backbone system.
4. The use of cellular phones was rejected because of the limitations of voice communications and the high cost of airtime, despite the fact that Oputus is a nationwide cellular carrier.

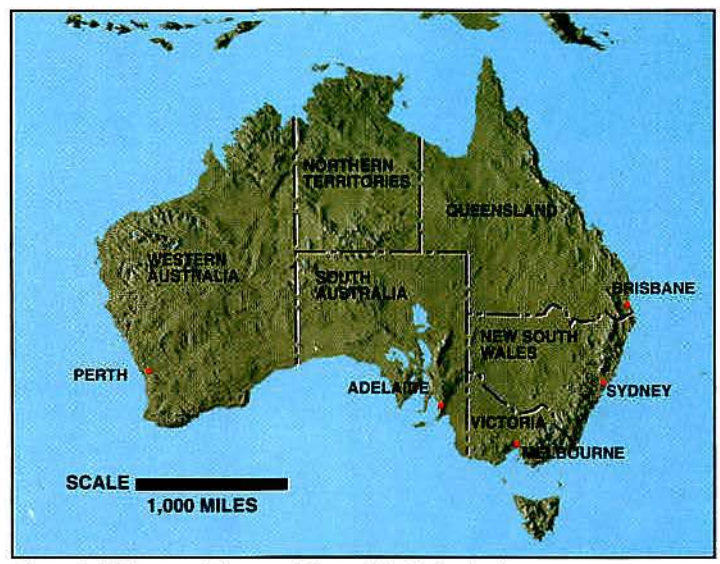



**Figure 1. Distances between state capitals in Australia are vast.**

## Nationwide mobile network

Optus Vision requested that King Communications Australia design a nationwide mobile data system. The first step was to list Optus' requirements, which included the following:

1. Nationwide coverage for voice and mobile data messages.
2. Simultaneous voice and mobile data transmission capability.
3. The ability to call individual vehicles and specific vehicle groups for dispatch calls, plus telephone interconnect for certain vehicles, over a wide area.
4. A vehicle radio capable of future upgrading to expanded data capability.
5. Rugged mobile data terminals with large display screens (readable in all light conditions) and status message buttons for simplified communications of detailed messages between the vehicle and the base.
6. Messaging software that provides fast, reliable data transfer between the mobile terminal and the base.
7. Operating capability with various types of trunked radio systems, pending final selection of the trunking format.
8. Operating capability with accessories such as bar code readers, printers and keyboards.
9. A flexible, user-friendly dispatch software program that meets a variety of customer requirements, not all of which were defined initially.

The communications system designed for Optus Vision uses the MPT1327 trunking format with Nokia Actionet controllers and base stations. It includes more than 30 sites in metropolitan areas with 7-20 UHF channels per site. MPT1327 provides wide-area, multisite coverage; simultaneous voice and data transmission; and telephone interconnect. Nokia R40 trunking radios were installed in the vehicles.

Australia is large, almost the size of the continental United States. Despite the large area it covers, the system is capable of

Scott is president of King Communications U.S.A., Orlando, FL. The assistance of Stuart Moffat, product engineering manager, King Australasia, is acknowledged. King Communications Australia designed the mobile data system described in this article. The proprietary messaging software system that King supplies is called HOST. The American company serves the United States, Canada and South America with mobile data systems compatible with LTR, SmartNet and Privacy Plus trunking formats in addition to the MPT1327 format described in this article.




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connecting any vehicle in the country with a central dispatcher after hours, an important safety feature. Figure 1 on page 46 shows the distances between the state capitals.

With the trunked radio system designed, the next step was to develop a mobile data dispatch system outline diagram that incorporates the principle hardware and software to be integrated into each local area system. (See Figure 2 on page 50.) This system connects directly with Optus' CMBS internal software and communications system. It provides a variety of customized mobile dispatch features and reliable data transmission over the MPT1327 system using our proprietary software system.

The messaging software system can provide as much as 6,000bps effective data throughput, even with 12.5kHz channel spacing. It incorporates a proprietary data compression and error-correction algorithm and operates reliably in marginal communications conditions. The Windows-based program enables a central control station to call individual vehicles by radio or telephone and downloads the data required to troubleshoot problems. The program comes with a dynamic data exchange (DDE) protocol and source code that allow simplified interface with virtually all available mobile dispatch software programs. For Optus, TransData's Trans-send transport management system software was selected and interfaced with the software messaging system and Optus' CMBS internal system.

CATV customer installation requests flow from the CMBS system to the Trans-send transport management system. The Workforce management team allocates the job to a field technician. The job informa-

## Public safety, utilities take advantage of mobile data offerings

Law enforcement agencies across the United States now have access to newly developed mobile data technology that will increase officer safety and, ultimately, community safety, thanks to AT&T Wireless Services, Tampa, FL; HTE, Orlando, FL; and Software Corporation of America (SCA), Stamford, CT.

SCA's Premier MDT 3.0, a public safety mobile data communications system, and HTE's crime management system and CAD III, a public safety computer-aided dispatch (CAD) system, have been integrated to perform over AT&T wireless networks to bring electronic state and federal law enforcement information and resources to laptop computers mounted in police cars.

SCA's Premier MDT software has been enhanced in version 3.0 to include text-to-voice, in-vehicle paging, mugshot and in-vehicle mapping. The text-to-voice feature "reads" vital information from the computer to the officer over speakers, allowing the officer to drive while responding to a call. Previously, officers had to read information from the computer screen and, by law, could not be moving at the same time.

Officers can also download mugshots to their laptops from the department's system, page officers from their laptops and use in-vehicle mapping with GPS to track and monitor vehicle location and map incident addresses.

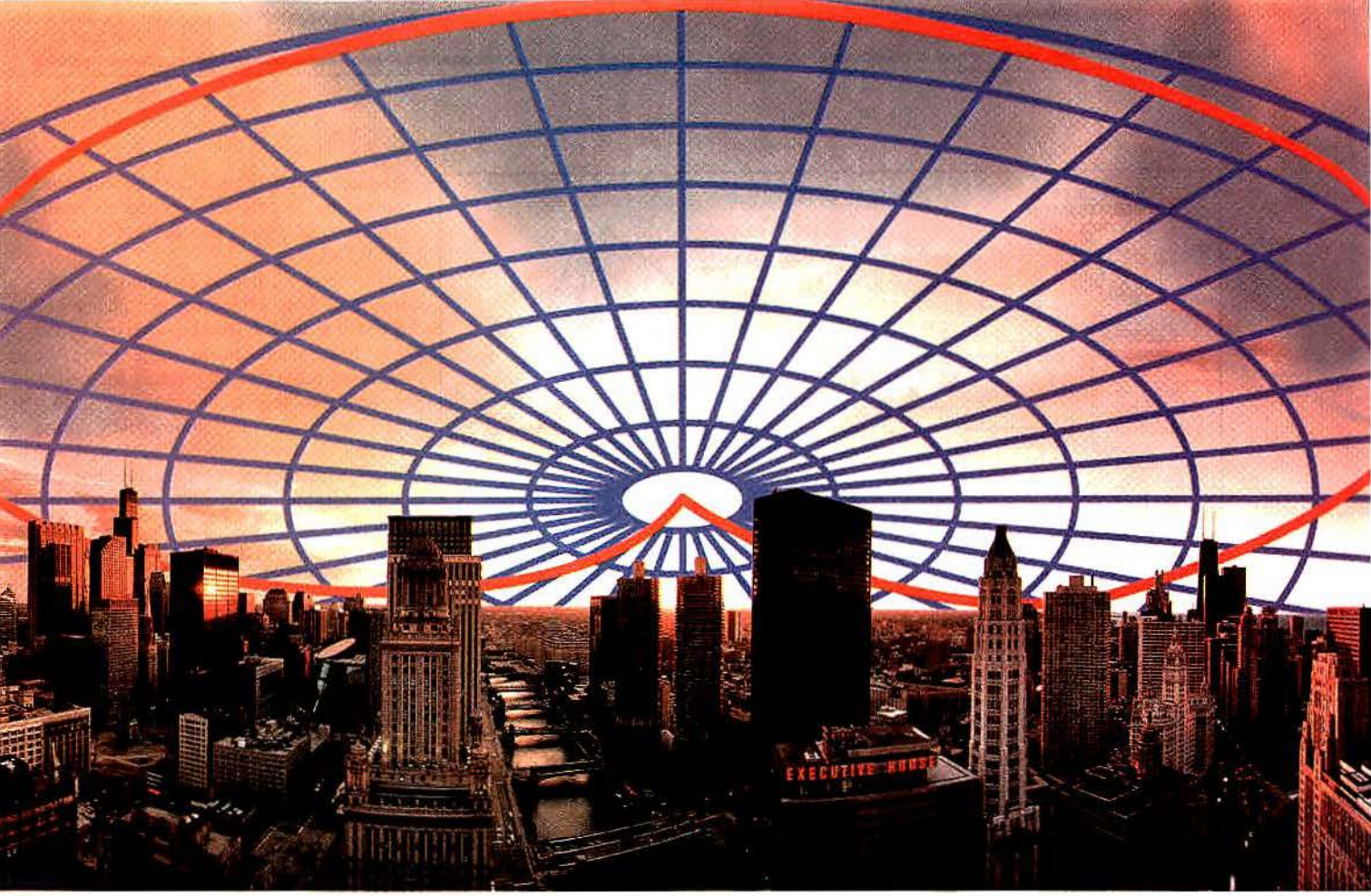
With this alliance, more officers have arrest records, warrant records and license plate information at their fingertips. HTE's CAD system allows the dispatch center to keep track of equipment and personnel locations, routing closest available units for response to calls and tracking call status through to completion. AT&T's Wireless Services is the cellular digital packet data (CDPD) service provider for the wireless system.

Carolina Power & Light, Raleigh, NC, has selected the Resource Management (RM) System from Alliance Systems, Itasca, IL, to improve the utility's emergency and service response time.

The system relies on client-server technology and operates within two-way, radiodata networks. At Carolina Power & Light, the RM System electronically links the utility's mobile field workforce with dispatchers and corporate data systems using wireless data technology and mobile terminals. The system includes such features as on-line order scheduling, advanced planner and dispatcher functionality, productivity reporting systems and intelligent mobile terminal processing. The system also provides a graphical Windows-based user interface, which allows personnel to use pull-down menus, simplified function keys and windows.



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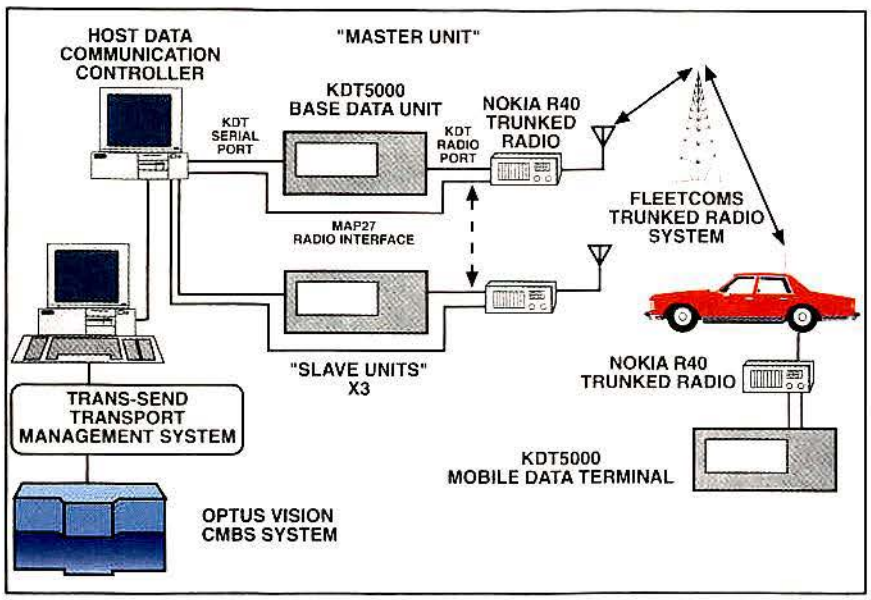



**Figure 2. The mobile data dispatch system designed for Optus Vision covers Australia.**

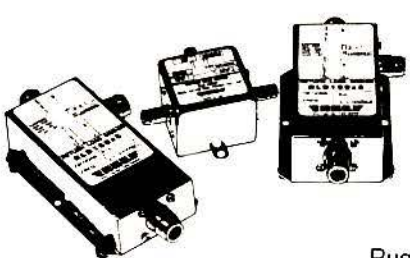
tion and technician number are sent to the software messaging system data communications controller.

The software messaging system is responsible for ensuring that the data are sent to the mobile KDT and for receiving the acknowledgment from the terminal. Once the mobile terminal acknowledges message receipt, the software messaging system advises the transport management system that the job is in the vehicle. If no acknowledgment is forthcoming within a predetermined time, then the software messaging system advises the transport management system that the job is not in the vehicle.

The field technician is required to accept the job by keying the acceptance key or risk that the job may be retrieved by the Workforce management team (using the transport management system) for reallocation to another technician. The technician also enters other information during the day that advises when jobs start and finish, which serial numbers are used and other relevant information. It is possible with the software messaging system controller to monitor the performance of the data throughput, call success rates and other characteristics. These can be used to fine-tune the system and to improve productivities.

Installation of the first MPT1327 system sites was completed in early 1996, and installation of R40 trunked mobile radios and King's DT-5000 mobile data terminals began in the second quarter. By June 30, 1996, 700 mobile radios and 250 mobile data terminals had been installed. By the end of 1996, these numbers reached about 1,500 mobiles and 700 mobile data terminals.


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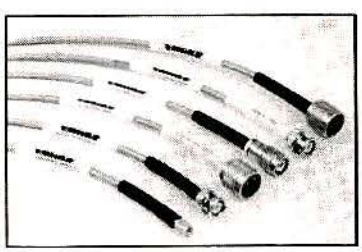


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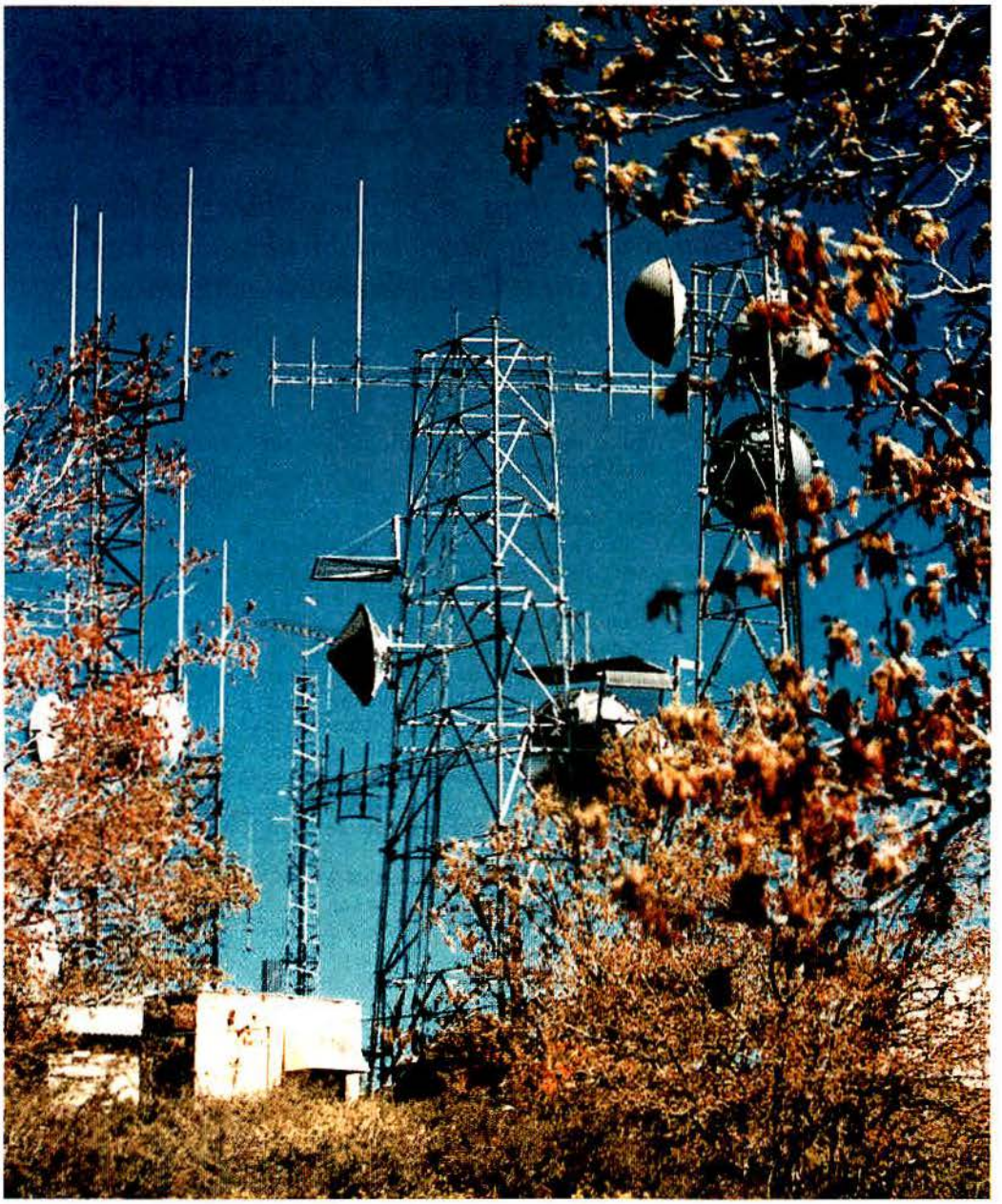
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# Repairing HSC and Mylar flexible cable technology

*Repairing or reworking connections in telecommunications devices such as pagers, two-way radios and cellphones requires an understanding of the physical properties of the connective materials.*

**by Bill Scheu**

Two types of flexible cable are used for various purposes in telecommunications devices. The most prevalent use is connecting a liquid crystal display (LCD) to a printed circuit board (PCB).

Mylar technology can be recognized by the presence of solder joints, an amber or dark green color and the presence of a TAB chip bonded to the cable. A heat-sealed connector (HSC) can be recognized by the absence of solder; soft, pliable cable; and black, green and yellow coloring. (See Figure 1 below.)

All Mylar cable technology can be repaired, reworked and replaced with a soldering iron, wire solder and solder paste, or a bonding unit. HSC technology is divided into three groups, each having a different criterion for repair, and it can only be replaced with a process bonding unit. For factory-bonded results, HSC material requires the application of controlled pressure and specific temperature for a precise time.

Scheu is president of A.P.E. South, Key Largo, FL. A.P.E. (Automated Production Equipment) manufactures equipment for rework and repair of intergrated chips and printed circuit boards.

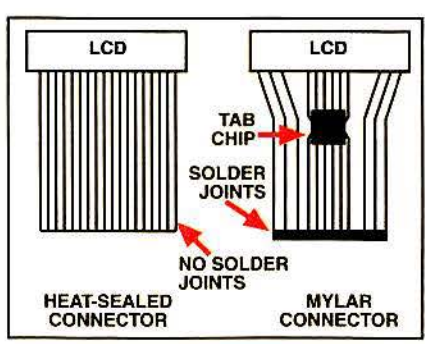



**Figure 1. Characteristics that distinguish HSCs and Mylar connectors.**

## HSC technology

Heat-sealed connectors are not soldered materials but, rather, a flexible substrate with conductive traces attached. The joint created by bonding (electrically and mechanically attaching) the connecting end of the HSC-type flex cable is the heat-sealed connector. The conducting traces, or "wires," are filled with conductive particulate material. This technology was developed to provide a quick and easy, but still reliable, method to connect an LCD to a printed circuit board. Telecommunications devices such as pagers, cellphones and two-way radios use this technology extensively. It is not necessary to understand the precise mechanics of the technology to replace or repair devices that incorporate HSC material. However, a technician will be more comfortable knowing *why* a repair or replacement is successful instead of only knowing *how* to perform the replacement.

Information about conductive epoxy and polymer technology, and specifications, is not readily available to the community of engineers working in the PCB environment, but understanding the physical properties and limitations is sufficient for successful repairs.

A good analogy is to think of the flex (ribbon) connector as a flat wire harness with each wire replaced by a bead of conductive epoxy. Visualizing this bead of conductive epoxy as being similar to a bead of caulking compound filled with metal particles will help illustrate the reasons for various time, pressure and temperature profiles that are required for different types of HSC material.

Temperature, time and pressure cause the conductive material to become plastic and make a mechanical, as well as an electrical, connection to the circuit card pad area. Different types of material require different profiles. Each type of HSC material has different metal particles in various amounts and sizes. Some materials require higher temperatures than others to change from a rigid to a plastic state. The pressure requirement relates to forcing the particles to make contiguous contact to ensure conductivity.

Three main types of HSC materials are in current use for telecommunications. Each type has its own mechanical and electrical characteristics that are unique and provide a range of price-performance features that can be applied to various products. The pitches, the spacing and size of the trace are different as well, as shown in Figure 2 below. Understanding the properties of the three types of HSC materials provides guidance for the repair of various products, as well as an appreciation of their use, removal and replacement limitations.

▶ *Monosotropic* — Used for fine pitches, monosotropic material can be recognized by its diminutive traces. If you can hardly see it, it is monosotropic. This material can be made to a pitch as fine as 0.22mm. The material contains gold and nickel particles and has a low contact

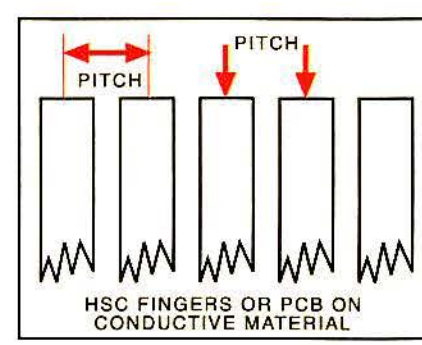



**Figure 2. Pitch is measured center-to-center. The closer the spacing is, the 'finer' the pitch.**




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resistance. Its yellow color denotes the titanium dioxide used in the manufacturing process when coating the connector with Thermoset adhesive. Monosotropic materials are used in Motorola Memo Express alphanumeric pagers, for example.

▶ *Anisotropic* — The lowest-cost material to yield reliable bonded joints, anisotropic material is filled with gold-plated nickel particles, and it is used in most pagers. Anisotropic material is also being used to manufacture replacement parts for planar materials used in pager technology. Anisotropic material can be produced in pitches as fine as 0.29mm, but for such a fine pitch, monosotropic material is usually used. The material's color is green-and-white or black-and-white. Anisotropic materials are used in Bravo Express pagers.

▶ *Planar* — The original pager connective material, planar is limited to pitches of 0.3mm or larger. It is more expensive than the other two types and contains no metal particles. Planar material is yellow with black traces that are usually easy to see. Planar materials are found in Bravo Alpha pagers.

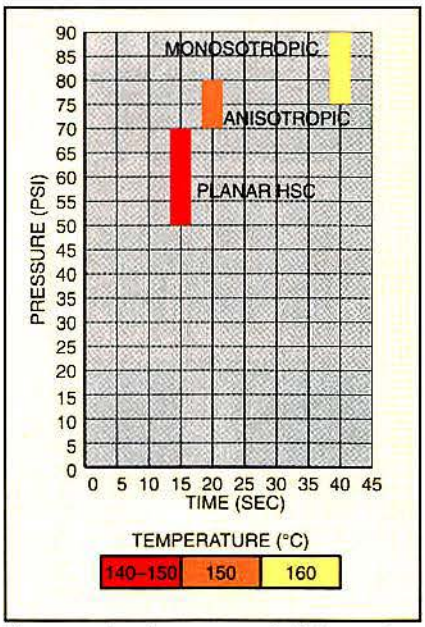



**Figure 3. The three types of HSC materials require different pressure, time and temperature settings to form a secure bond.**

Bonding (establishing a mechanical and electrical connection) of these materials requires temperature, pressure and time As shown in Figure 3 above, each of the three materials has different bonding requirements. There is an operating time, temperature and pressure envelope for each type of material.

When replacing an HSC connection, note the properties of the material used. When bonding a monosotropic material, for example, if an anisotropic pressure of 70psi is applied, then the bonded joint will *look* fine, but it will not have a proper mechanical connection to the pad. The joint may even work for a short time—then fail when the device is dropped or undergoes an ambient temperature change. If an anisotropic material is bonded at a monosotropic temperature, the insulating material between the conductive traces could melt and short. If a planar material is bonded at the high end of the monosotropic pressure envelope, then the bonding head could cut the material.

If the HSC cable is peeled away from the circuit card, then the residual conductive material on the pad areas of the PCB will reveal the way a properly bonded joint appears after bonding, as




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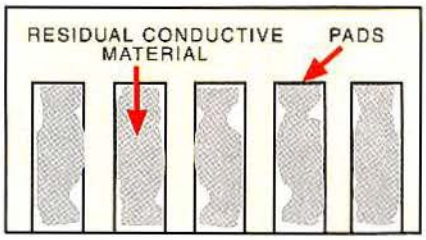



**Figure 4. Residue covering 90% or more of the surface indicates a good bond.**

shown in Figure 4 at the left.

### Mylar technology

Flexible cable, using Mylar technology, is essentially a flexible PCB. The conductive traces are copper and, in most cases, are plated with solder. The *techniques* of working with flexible cable are the same as those used for working with PCBs, but the material will not tolerate the *temperatures* of 600°F–750°F used to repair

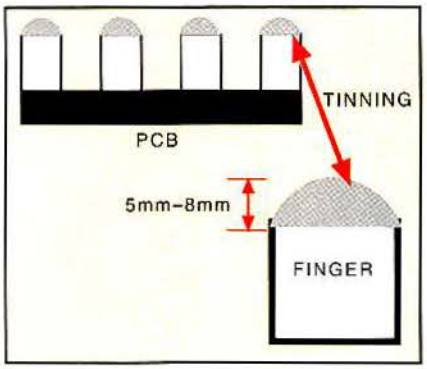



**Figure 5. Tinning of the pad areas of a PCB.**

PCBs. The best working temperature is beween 375°F and 400°F. A high thermal mass, digitally controlled soldering iron or bonding unit will ensure damage-free rework of devices using Mylar.

### Flexible circuit replacement

▶ *Mylar* — Removal of the old flex cable is usually performed with a digitally controlled soldering iron set at less than 700°F. As the joints reflow, apply a peeling pressure to disconnect the solder joints. After cooling, the receiving pad areas on the PCB card should be tinned with a 63/37 soldering paste or wire as shown in Figure 5 above. Some Mylar flex cable requires solder tinning prior to installation. Two types of pad areas on Mylar flex cable are *supported*, meaning that Mylar material is between each finger (such as in the Advisor pager), and *unsupported*, meaning there is no material between the fingers. Before attempting to tin unsupported fingers, tape a piece of Kapton anti-static tape over the fingers. The tape will prevent the fingers from bending or distorting out of shape.

▶ *HSC technology* — To remove a damaged or defective HSC cable, secure the LCD and gently peel the cable from the PCB pad areas. A residue of conductive material will be on the PCB fingers, as shown in Figure 6 below. The residue must be removed completely prior to installing a new HSC cable. Residual material can cause an electrical short in the device after the installation.

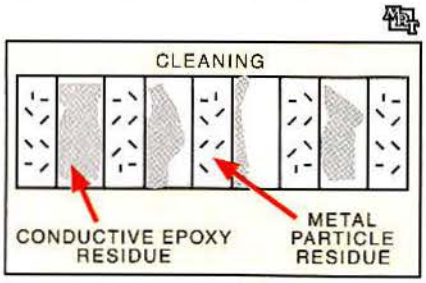



**Figure 6. Residues should be removed from PCB pads before installing a new cable.**

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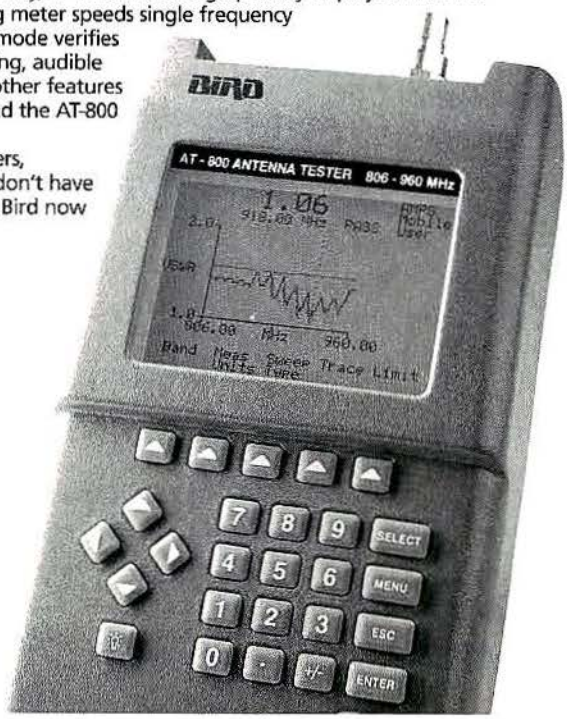
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# Global positioning systems: A 21st-century technology

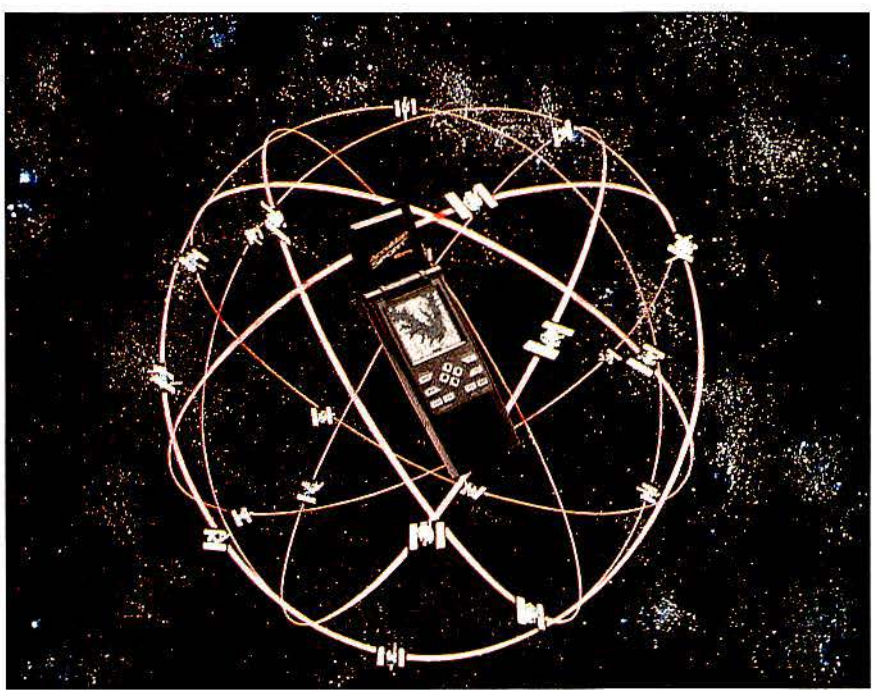
*Global Positioning System (GPS) technology is coming into the mainstream. Once reserved for only high-end geographic applications, this technology is finding its way into K-Mart, Wal Mart, sporting goods stores and mail-order catalogs.*

**By Ernest Worthman**

Cutting-edge technology in component development and large-scale integration, as well as new markets, have brought about GPS technology's move from the public to the private sector.

Satellite-based GPS technology relies on differential satellite positions to pinpoint locations. The navigation satellite timing and ranging (NAVSTAR) system was built and is maintained by the U.S. Department of Defense. The system uses 24 satellites, plus two spares, operating in six orbital planes 20,200km (10,900 nautical miles) above the earth at inclination angles of 55° with a 12-hour period. The satellites are positioned precisely so that a minimum of four always are in view of the user with a position dilution of precision (PDOP) of six or less.

Each satellite transmits on two L-band frequencies, L1 (1,575.42MHz) and L2 (1,227.6MHz). All satellites use the same L1 and L2 frequencies. Even so, each satellite's signal is Doppler-shifted by the time it reaches the user. L1 carries a precise (P) code and a coarse and acquisition (C/A) code. L2 carries only the P code. A navigation data message is superimposed on these codes. The same navigation data message is carried on both frequencies. The P code normally is encrypted, so that only the C/A code is available to civilian users. Some information can be derived from the P code. When encrypted, the P code is known as Y code.



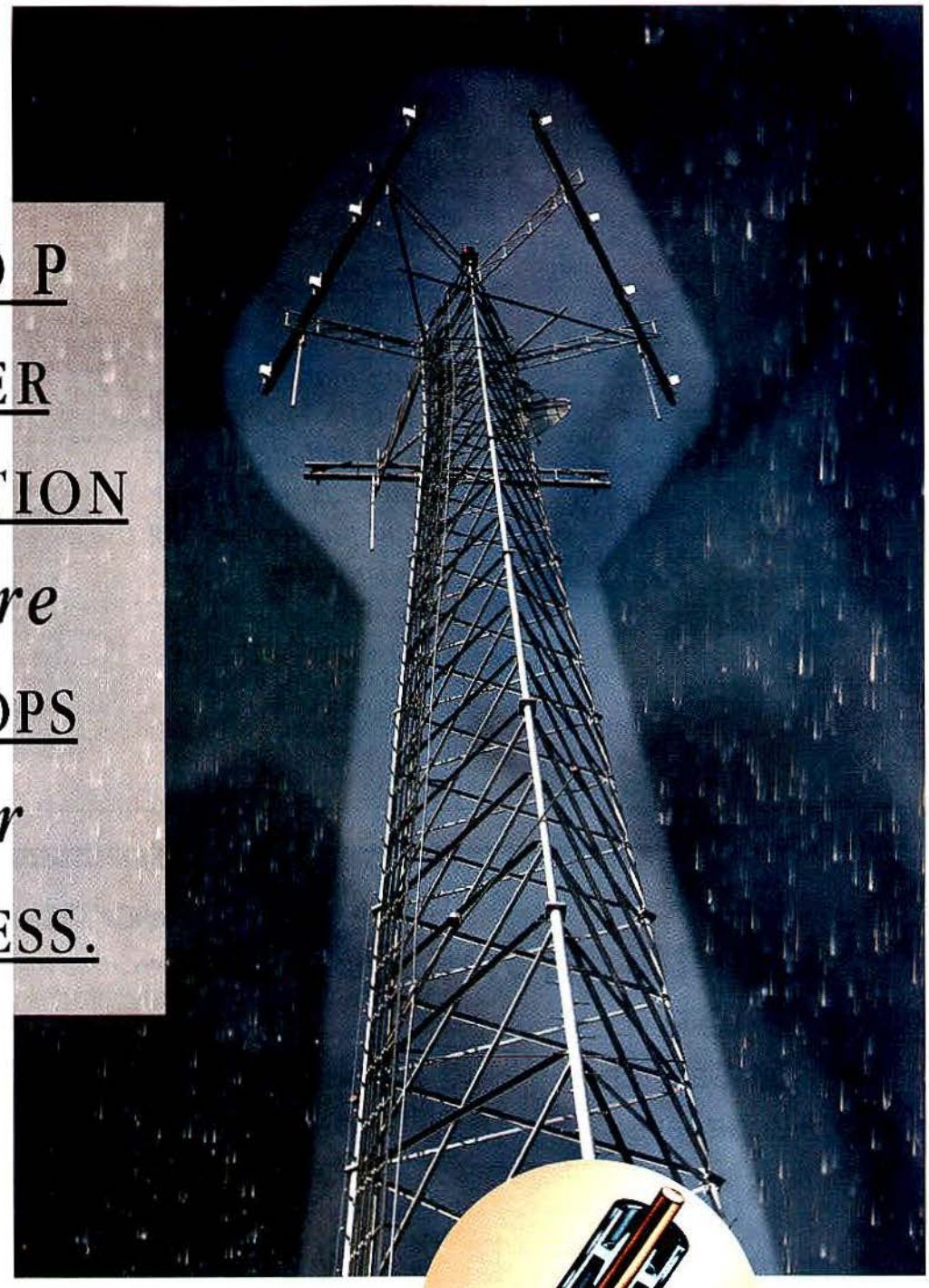
To locate positions, readings are taken from different satellites. Three satellites can be used for a two-dimensional position fix, but four are required for height above terrain (HAT). The receiver takes the data from each of the four known transmission sources (the satellites) and determines the time it takes for the signal to arrive at the receiver. This range is called the *pseudorange*. Solving for the four unknowns, Ux, Uy, Uz, and Cx (clock bias) provides a differential time element based on the time it takes for the signals to reach the receiver, relative to each satellite's position. The data received determine the device's position in latitude, longitude, altitude and time. These data are then converted into latitudinal and longitudinal coordinates from which position, speed and time can be determined. Because the elements are time, speed and distance, GPS works in a three-dimensional plane, allowing for land, sea and air applications.

### Accuracy levels

GPS comes in two flavors: *standard positioning service* (SPS) and *encoded precise positioning service* (PPS). The PPS is a non-reduced service, primarily used by agencies that require extremely accurate readings, such as the military, emergency services, public works, fleet vehicle services and U.S. Geological Survey (USGS) mapping. PPS is capable of providing accuracy of 16m or less in positioning, 0.1m in velocity and 90ns–100ns in time.

The SPS commonly is used in the commercial environment and provides position only to an accuracy of 100 meters.

Worthman is contributing editor with *RF Design* magazine.



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SPS signal accuracy is intentionally reduced by the government to protect U.S. national security interests. This reduced accuracy, called *selective availability* (SA), controls the availability of the system's full capabilities.

As is often common to encryption or encoding technology, methods soon develop to defeat these schemes. Commercial manufacturers have developed a way to eliminate most of the effect of SA by what is called *differential GPS* (DGPS). DGPS adds stationary receivers at known points on the ground. The receivers transmit low-rate (100 bits per second [bps]) data at a frequency of about 300kHz. These transmitters relay error-correcting data to the receiver and improve accuracy to 10 meters or better. Accuracy also can be affected by ionospheric conditions and ground clutter such as woods, buildings and multipath signal reflections. Under ideal conditions, GPS receivers are limited to an accuracy of about 2m.

**Technology**

For a long time, commercial GPS receivers were stand-alone components. The user would be required to make the receiver integrate with his application. Today's GPS systems are becoming more complete. When a GPS system is deployed, it tends to include support data, such as navigation maps and post processing software. For example, a commercial GPS unit sold to the automotive market may contain not only the receiver, but also localized data maps of city streets for the area in which the unit is being sold. It also may contain a car power adapter kit, external antenna and even software to allow the user to modify the database. In this application, the GPS becomes a component of a complete product. This trend also is being seen in commercial markets such as airline navigation and law enforcement.

*Today's GPS systems are becoming more complete. When a GPS is deployed, it tends to include support data, such as navigation maps and post-processing software.*

Greg Turetzky, a product manager at SiRF Technology, a GPS front-end component manufacturer, says the approach that SiRF is taking is to apply *very large scale integration* (VLSI) techniques to shrink the module and lessen component count. From a design standpoint, the GPS modules of the receiver comprise two chips, an RF converter module, largely made up of bipolar components and the complementary metal oxide semiconductor (CMOS) digital signal processor (DSP). The front-end section is the RF portion that takes the signal, which can be as low as –160dBm at about 1.5GHz, processes it and converts it to digital output of a few hundred millivolts. The digital output is fed to the DSP section. The function of the hardwired DSP is to remove the spread-spectrum encoded portion of the signal and to convert it into basic in-phase and quadrature (I and Q) for running track loops.

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typical of many manufacturers in many industries in which a standard component approach is being developed. Turetzky points out that SiRF is attempting to make the inclusion of a GPS module easy for the product developer. SiRF's approach "is to make it easy for people who aren't skilled in RF design to be able to add this to their product." By adding a handful of external components, such as filters, reference crystals and bias components, for example, a complete GPS front-end is made available. It is this technology approach that opens doors for commercial GPS.

As this technology develops, it is likely that we will see an integrated RF and DSP unit that will offer advantages such as improved signal-to-noise ratio, simplified interconnect and better immunity to environmental interference.

**Applications and markets**

In the early days of GPS, the principle markets were surveying and timing. Before GPS systems were used for marine navigation, the compass and the Loran coastal navigation system were the only ways mariners could navigate. The compass was not particularly accurate, and Loran only worked in coastal waters. GPS provided a one-stop application for both open seas and coastal navigation and even provided a precise location device for inland water bodies. A secondary benefit was that the user did not have to learn to navigate by stellar. It was necessary only to take a GPS position fix, look at the charts and point the boat to a compass heading. GPS was simpler than previous methods.

*Before GPS systems were used for navigation, the compass and the Loran coastal navigation system were the only ways mariners could navigate.*

GPS is beginning to find its way into people and package tracking. This type of application has a unique set of issues that other tracking objects do not. First, these objects are not always outdoors. Second, the object is not always moving. Once a person or a package is surrounded by massive brick and steel structures, signal reliability drops markedly, and if the object is not moving, there is no $\Delta t$. The challenges that GPS faces in this arena are to try to improve sensitivity to these minimal signal levels, which may be −160dBm or greater, and to intelligently sense whether the object has stopped moving. A rather ambitious project would be to attach a GPS receiver to packages delivered by courier services.

Another technology area that is likely to see the implementation of GPS is personal communications. Cellular phones are a prime candidate for integrated GPS. In an emergency, dialing 9-1-1 from a cellular phone does nothing to determine the actual location of the phone (unlike landline phones, which can be traced). According to one industry source, the FCC is prepared to require a certain percentage of cellular 9-1-1 calls to be locatable within a defined area within a set time period. GPS in-building unreliability,

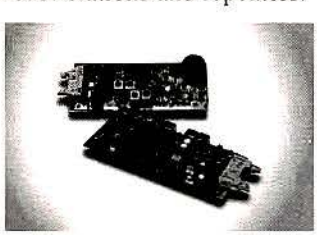

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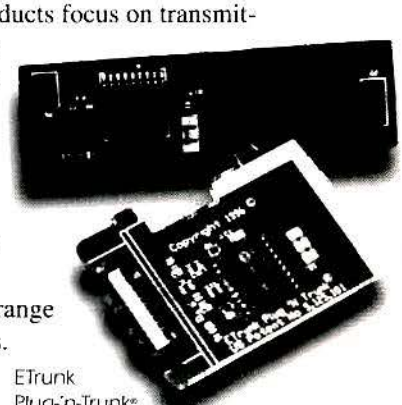


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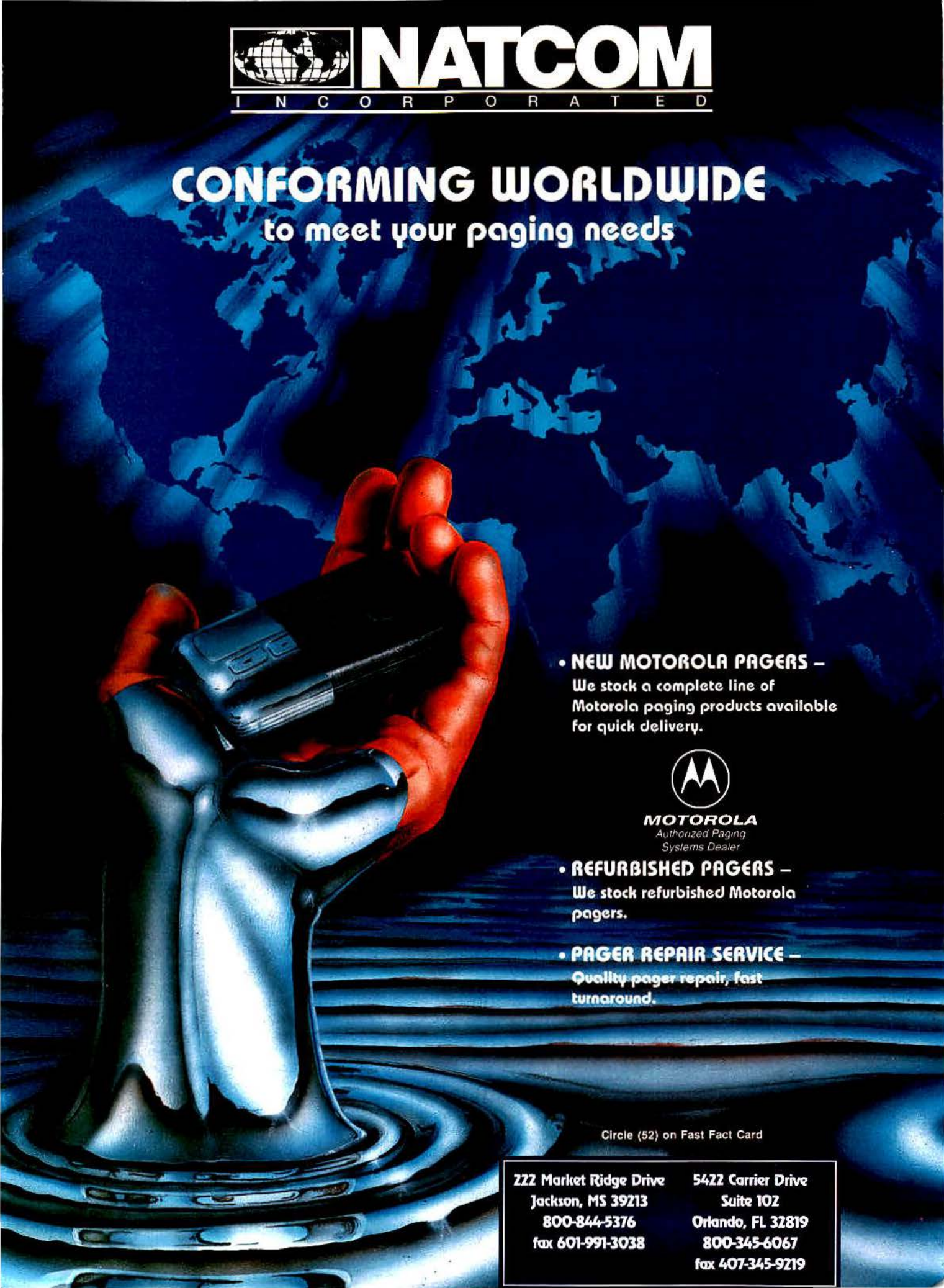
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blocked signal areas and movement requirements are likely to cause debate over this type of technology.

**The obstacles**

Although there have been a great number of advancements, GPS technology needs further refinements. To use an industry vernacular, GPS signal strength at the receiver is in the mud. Imagine you are an integrated, ultra-sensitive receiver in a cellular telephone looking for a signal at –160dBm. All of a sudden a 3W, 900MHz cellular transmitter, only a few inches from you, fires off. Even though the transmitted freqency is 600MHz away, the power radiated at the proximity of the receiver is close enough to affect and sometimes damage the sensitive front end of the GPS receiver. Even with today's high isolation and rejection devices, the super-sensitive GPS receiver is always affected by the proximal power.

GPS manufacturers face power consumption also. Today's GPS receivers have a steady-state power drain of around 750mW. Hand-held GPS receivers usually use 6V battery configurations (1.5V × 4 cells). Some quick math reveals that the current drain is 125mA. Although this does not seem like much of a drain, add in the display (popularly the liquid crystal type) and some other support electronic, such as DSP, and it becomes an issue. To improve on time between batteries (TBB), various power-saving schemes are supported, such as powering down the components when the unit is not in actual receiving mode, or after a specific period of non-use is sensed. Even so, to maintain updated positioning information, the receiver still has to make periodic calculations, even when the unit is in standby mode. Ways to reduce power further are still high on the list of developmental projects.

*The sensitive nature of current RF technology still requires careful shielding, grounding and component placement.*

The sensitive nature of current RF technology still requires careful shielding, grounding and component placement. Although digital components have relative immunity to spurious emissions, high-frequency RF circuitry does not have that luxury. High-speed microprocessors running at 100MHz and higher can wreak havoc with ultra-sensitive RF sections.

**The future**

As was mentioned earlier, most of the movement in the GPS industry is in trying to improve receiver sensitivity and to deal with stationary receivers. This translates into the issue of reliable signal levels. At a certain level, the receiver loses phase lock but not necessarily the signal itself. Although maintaining phase lock is required for guaranteed accuracy, some of the industry designers are looking at methods that can sense signal, even though it is too low for the phase-lock-loop (PLL) circuitry's threshold. Even at signal levels of –180dBm and below, if the signal can be identified, some information still can be gleaned. If


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this information can be identified by using digital enhancement technology, it is possible to make it useful in position location. As Turetzky indicates, part of the new technology is a paradigm shift in perception.

If the position fix is not accurate to 1m, but is accurate to 100m, does that make the data unreliable? If you were hiking and got lost in the woods, would you throw away your GPS receiver just because it could fix only to 100m rather than to 10m, or would you rather have the rescuers looking all over the mountain? Even though the information is not 100% reliable, it is not useless. Consider today's cellular technology. If it had to be 100% reliable, none of us would be using it.

GPS appears to be a means to an end, rather than the end itself. As a stand-alone product, latitude and longitude are not hot items outside of surveying and navigation, but as an integral part of 21st century technology, GPS has a bright future. For example, consider using a GPS receiver to keep your portable computer's time set or as a small light emitting diode (LED) on your automobile's instrument cluster that will locate you on any street or highway and then reference the data to the local geography and populous.

As with any high-technology industry, GPS is benefiting from the developments in surface-mount technology (SMT), VLSI, low-power devices and other advancements. Another area of development is in embedded processors and microprocessors in general. It is likely that many of the functions, once exclusively the domain of discrete components, can be emulated and will be provided in a digital format as processor speeds approach 500MHz and eventually break the gigahertz barrier. Faster processors will allow the elimination of much of the frequency manipulation and conversion techniques we now use to bring the frequencies into workable digital range. The future chipsets likely will look like a universal asynchronous receiver and transmitter (UART), just another component that gets called into use when needed. Microsoft is designing a position navigation application program interface (PNAPI), so computers with the operating system can position-tag data if needed, and GPS manufacturers can easily design software driver interfaces for their products.

The final limiting technology in GPS is the satellite system itself. Although it is relatively easy to update earth-bound hardware, to do the same to satellites involves launching new ones (or going aloft and updating the existing ones). Either way, it is an expensive proposition, but the power of the commercial market is one that is hard to ignore.

## What's new in GPS?

Low-cost GPS technology may be the next opportunity for consumer GPS systems. At any time, under ideal conditions, a GPS receiver could gather data from 12 satellites. On the other hand, the system is designed to permit precise positioning calculations with data from only four. Somewhat less precise positioning can be obtained using three satellites. The application of digital technology and VLSI, coupled with innovative design, makes it possible to continue calculating position "fixes" with only a single satellite's signal.

Single-satellite positioning is critical for GPS use in urban areas. Automobiles equipped with GPS-based accessories often travel on narrow streets surrounded on two sides with tall buildings. Such "urban canyons" can obliterate reception of more than one satellite's signal. With single-satellite positioning, positions can continue to be fixed and are corrected as soon as an automobile enters an intersection, permitting multiple-satellite signal reception.

A key to this capability is the receiver's ability to quickly access satellite signals while the automobile proceeds through the intersection. As a result of the fast movement of vehicles combined with the canyon effect, acquisition technology must be designed to achieve re-acquisition in as little as 100msec, much faster than the more typical two to three seconds required by other technologies. To achieve such quick re-acquisition time, new technological developments, such as parallel spectrum search involving 20 code samples at a time, are needed, and parallel spectrum search is coming on the market.

Another problem associated with urban areas is multipath errors. Signals bounce off buildings, introducing time delays in reception and positioning errors. Dual-multipath rejection technology eliminates low-level reflected signals and filters higher-level reflected signals. Without multipath rejection, such errors can produce large-scale positioning deviation.

Finally, GPS originally was designed for use with expensive, spread-spectrum receivers. The standard signal threshold is –160dBw. This permits receiving a signal that is much reduced in power. Consumer products with GPS capabilities often will be used in wooded or tree-lined areas, where signal levels tend to fall below this threshold. Therefore, increased sensitivity receivers allowing sensitivity 20dB lower than the threshold are needed for these conditions. Thus, signals that are indistinguishable to other GPS receivers are easily detected.

These issues and their resolutions are only part of the developing market for GPS. The combination of GPS innovations and consumer demand is making it possible to provide fast, accurate, personal positioning information in almost any outdoor location, using hand-held consumer products that sell for less than $200.

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*(continued from page 8)*

the antenna height, antenna gain, antenna orientation, transmitter and antenna location and transmitter power. It may be necessary to try a combination of several of these methods to effect a satisfactory solution.

**Last resort**

Obviously, if all else fails, it will be necessary to request intervention from the FCC.

Such a request should be avoided if at all possible. If it is necessary, then you should be well prepared with documentation to show that the other party is indeed causing destructive interference to your radio system.

Logs showing dates and times of the destructive interference might prove helpful. Tape recordings of transmissions being blocked by the offending signal are useful in proving a case of blocking or serious degradation of the desired signal.

You should have plenty of recorded signal level readings on different dates and times for the FCC's examination and consideration.

**Signal level measurements**

The simplest method of measuring the offending signal's level is to use a spectrum analyzer as shown in Figure 1 on page 8.

Most spectrum analyzers measure signal level in dBm units. If you want to convert dBm units to microvolts, use the following formula:

$$\mu V = \text{antilog}\left[\frac{\text{dBm} + 107}{20}\right] \quad (1)$$

Example: Suppose, using the setup in Figure 1, the signal level was found to be 290dBm. Substituting into the formula, we have:

$$\begin{aligned}\mu V &= \text{antilog}\left[\frac{-90 + 107}{20}\right] \\ &= \text{antilog}\left[\frac{17}{20}\right] \\ &= \text{antilog}[0.85] \\ &= 7.08\mu V\end{aligned} \quad (2)$$

This is the signal level at the spectrum analyzer input, and it would be the same at a receiver input.

**Receiver method of measurement**

Another way to determine the signal level at the receiver input (when metering points are provided) is to check the meter reading at the IF metering point with the signal on the air.

Record the meter reading for reference. Then, connect a signal generator to the receiver input and adjust the generator level to produce the same meter reading. Read the signal generator level in microvolts or dBm. This is the signal level of the interfering signal.

**Converting to μV/m**

To convert the signal level at the receiver input in microvolts or dBm to *field strength at the antenna* in microvolts per meter (μV/m), use formula (3) or formula (4), as appropriate, as shown in the box on page 68.


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**Formula 3**

$$\frac{\mu V}{m} = \text{antilog}\left[\frac{20\log(\mu V) - G_R + 20\log F + L_L - 32}{20}\right]$$

**Formula 4**

$$\frac{\mu V}{m} = \text{antilog}\left[\frac{dBm - G_R + 20\log F + L_L + 75}{20}\right]$$

where

$\mu V$ = signal level at receiver input in microvolts
dBm = signal level at receiver input in decibels below 1mW
$G_R$ = antenna gain of the receiving antenna in dBd
$L_L$ = line loss in decibels
$F$ = frequency in MHz

If the signal level at the receiver input were in dBm, you would use Equation (4) above to find the field strength in microvolts per meter at the antenna.

To determine how much the interfering signal is degrading the desired signal, use the equipment setup shown in Figure 2 on page 8.

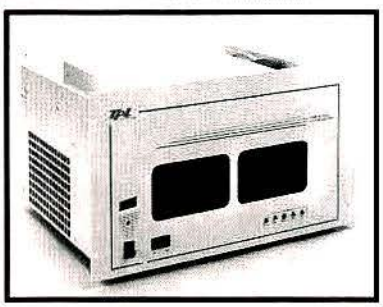
The *isotee* is a homemade coupling device that is very lossy and has a negligible loading effect on the line. The isotee is made by removing the center pin from a T-connector, cutting it off short and then reinserting it into the T-connector.

Then the female-female UHF adapter is attached to the T-connector. Because the T-connector's pin has been cut off, no direct contact is made between the double-female UHF adapter (barrel) and the T-connector; nevertheless, RF leakage within the connector provides some degree of coupling with considerable isolation between the signal generator and the line. Similar isolation couplers can be made with other types of RF connectors.

**Measurement procedure**

(1) With no incoming signal from the antenna and with the signal generator set to the correct frequency and modulated at ±3kHz deviation, set the generator level to produce 12dB SINAD. Record the generator level in dBm. (It will take a high signal level to produce 12dB SINAD because of the loss or isolation of the isotee.)

(2) Wait for the interfering signal to make an appearance. When the interfering signal appears, increase the signal generator level to return the SINAD meter reading to 12dB SINAD. Record the new

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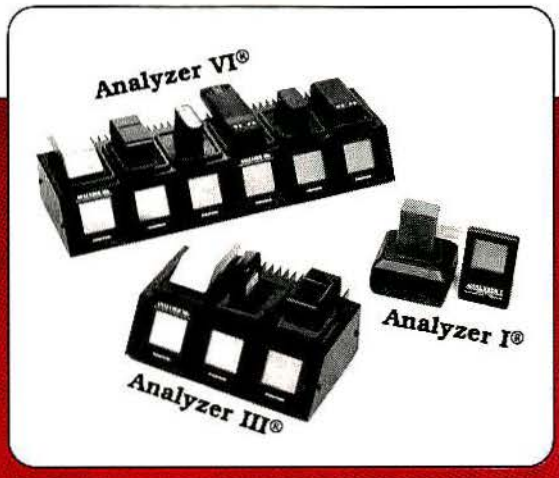
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signal generator level.

(3) The difference between the generator levels in steps 1 and 2 in decibels is the amount of degradation the interfering signal is causing to the desired signal.

If your radio system operates at consistently stronger signals than the *minimum usable signal level* (12dB SINAD), then you might choose a higher input level as the reference. For example, 1μV might be a good choice if your signals are always this strong. Of course, the measurement would indicate less degradation at 1μV than it would at the 0.3μV level, for instance.

This information should help you to establish the magnitude or the severity of the interference problem. The severity of the interference may vary from day to day and time of day. If the problem occurs frequently and with severe degradation, it can render your radio system very unreliable.

But before taking your case to the FCC, arm yourself with information and documentation.

Until next time—*stay tuned!*

**Formula 5**

$$\frac{\mu V}{m} = \text{antilog}\left[\frac{20\log(1.5) - 6 + 20\log(160) + 3 - 32}{20}\right]$$

$$= \text{antilog}\left[\frac{3.52 - 6 + 44.08 + 3 - 32}{20}\right]$$

$$= \text{antilog}\left[\frac{12.6}{20}\right]$$

$$= \text{antilog}[0.63]$$

$$= 4.27$$

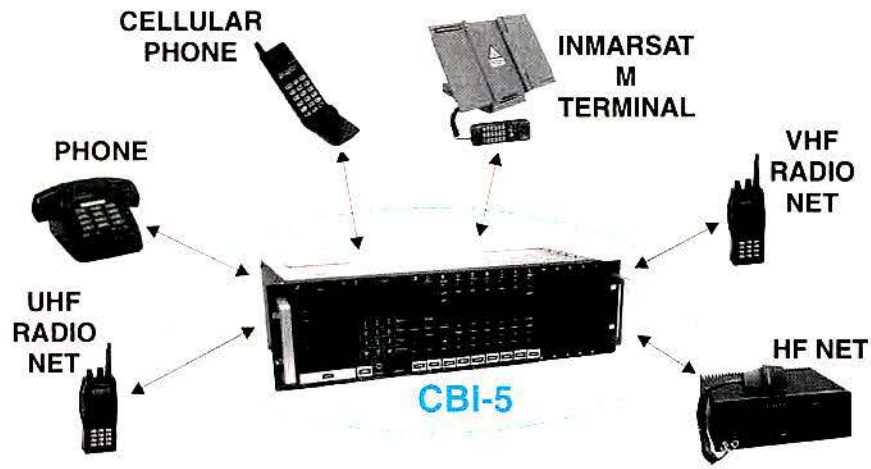

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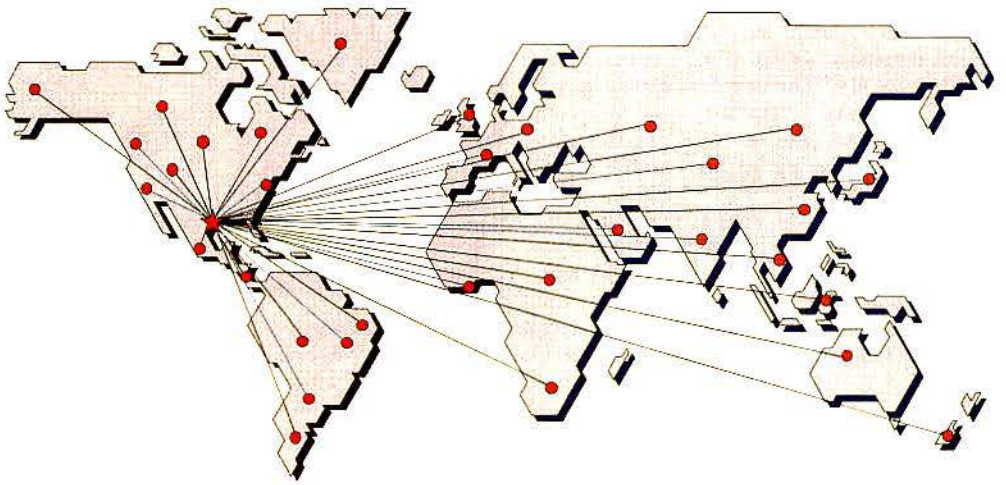
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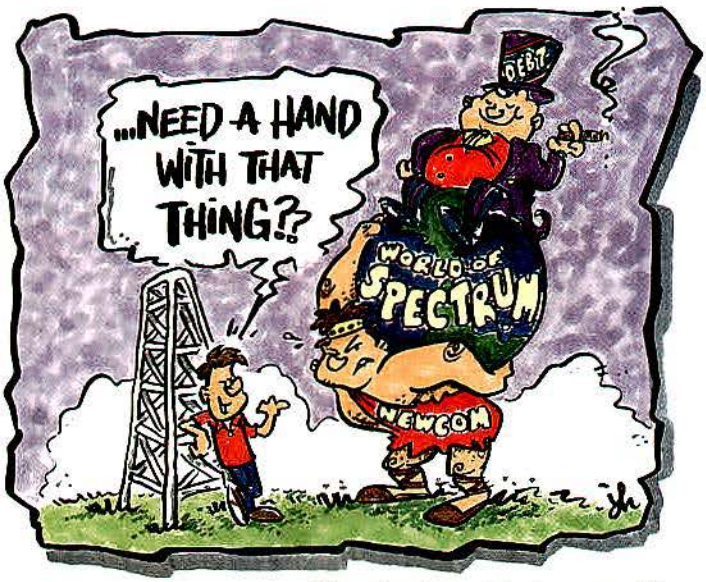
# Sweat- and debt-free

By Robert H. Schwaninger Jr.

Most of the larger markets are experiencing rapid build-outs of new telecommunications services, including PCS and two-way paging, to add to the present roster of wireless services. Usually backed by big, centralized, investment groups that radiate from Wall Street like glow worms on an inky night, the activity to feed the American public wireless services of every kind and feature is heating up across the landscape.

Incumbent, local operators, who didn't acquire regional licenses to be the carrier of these services by participatng in past overheated auctions, are trying to determine where they fit into this swirling mix of new services. Is PCS a threat or an opportunity? Will two-way paging cut into traditional markets or expand existing customer bases? And so on.

Although my crystal ball is still cracked and those tea leaves are getting pretty wilted, some predictions and admonitions might still be offered. Not that I, or anyone else, can make perfect sense of the telecommunications landscape, other than to say that rapid change is here, and with it come windows of opportunity that open and close in the space of a breeze.




## Spectrum glut

If you read the "old" (more than five years) petitions, orders, memoranda and articles about our industry, you will see consistent references to "scarce spectrum resources." That cliché is being legislated out of existence. With advanced technology that employs ever-higher frequencies for commercial purposes (witness the new 2.3GHz block that was technically untouchable 10 years ago), the FCC is able to sell large blocks of spectrum to operators

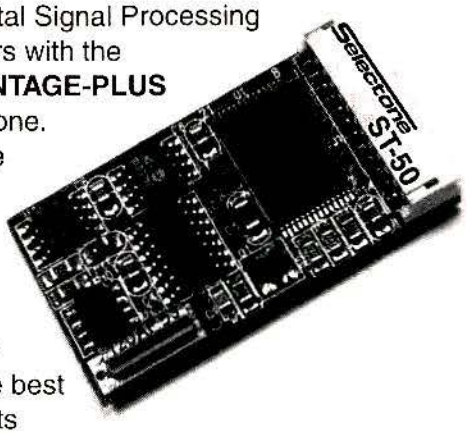
Schwaninger, *MRT*'s regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

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for flexible use. Therefore, scarcity of spectrum above 800MHz is becoming passé.

What will become more important in the future are market share, revenue per unit, distribution chains and outlets, service compatibility, market penetration, integration of systems and design, numbering plans, interconnection capacity, technical support, and the host of other factors that convert spectrum into revenues that produce positive earnings. Each of these factors represents a significant hurdle for regional and nationwide carriers, and many of these factors represent potential opportunities for local operators and service shops.

The value of an entrenched service base, goodwill, market reputation, and access to decision makers, places a premium on a local presence that is not easily duplicated. Despite the allure of national ad campaigns, the American consumer still has a preference for dealing with a business that is local in character. My conversations with hundreds of operators across the country continues to affirm this impression, despite the onslaught of new upscale services and providers.

The desire to cast a large net to land the biggest fish in a market is what drives most nationwide carriers. The bigger the carrier, the bigger the "holes" in the net through which swims a substantial market share. Even AT&T admits that its foreseeable plans for delivering local phone service only target the top 30% of the major markets, including mainly large business and government accounts. The other 70% is left for others to fight over.

Fight they will, but mainly with one another. New wideband services require substantial capitalization. The costs of auction, build-out, and start-up are enormous. The era of mobile unit giveaways is sliding into the past, as companies simply cannot afford this largesse to add subscribers, because of a shrinking profit margin and increased capitalization costs. Therefore, mobile unit sales will also slow market penetration for some carriers, as customers opt to keep what they have, rather than bear the cost of the newest gadget.

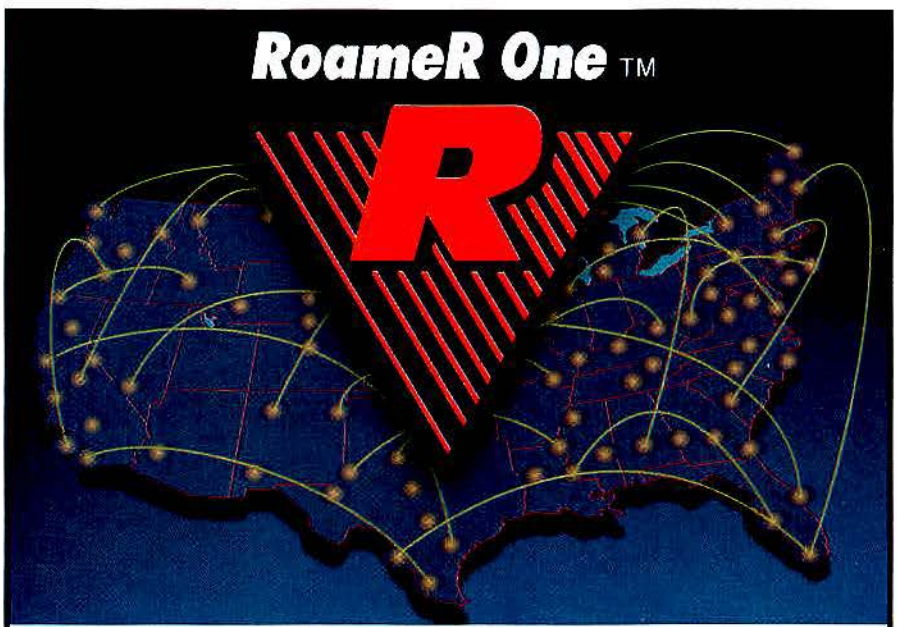
The irony is, then, that larger carriers will be forced to compete in an increasingly localized manner. Churning out full-page ads and one-minute radio/TV spots will not result in the kind of return that is needed, unless backed by local operators, resellers, retailers, service shops or distribution providers. Broadcast marketing techniques will result in all sound and no lasting substance. (Sorry, Nextel.)

The need to create a local presence by building relationships with local operators and providers will become increasingly apparent. The market will be divided, subdivided and fought over for every dollar among two cellular providers, three wideband PCS providers, a half-dozen narrowband PCS providers, ESMR providers, and whatever new providers the FCC creates by auction over the next few years.

Most prognosticators have said that there will be a shake-out of competitors throughout the industry, with many of the new players falling out because of failed strategies, default on auction payments and an inability to attract necessary financing. I agree, but for reasons that most experts have ignored.

### High-handed tactics, shallow pockets

Most of the upstart carriers in PCS have focused on Wall Street or foreign investment to obtain the financing necessary to begin. The rarified atmosphere of board


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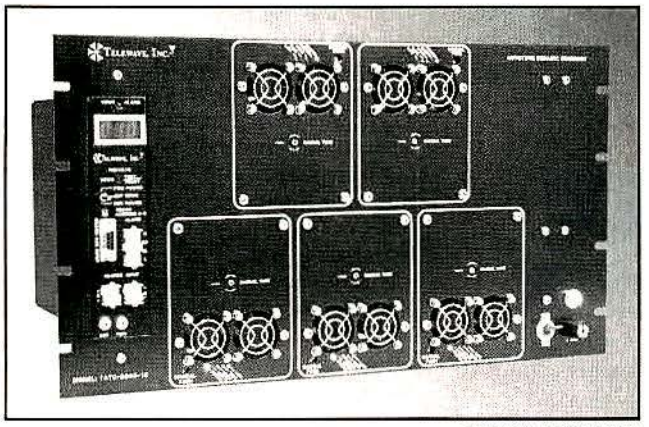
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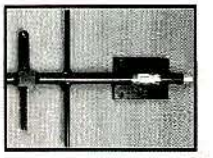
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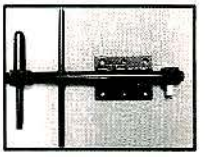
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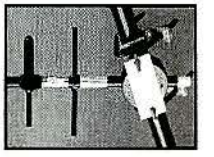
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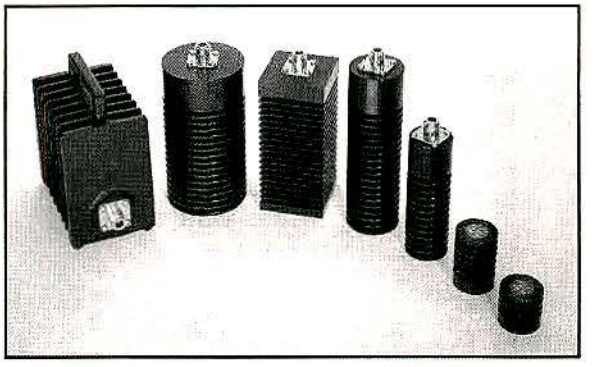


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**Circle (64) on Fast Fact Card**

rooms, brokerage luncheons and media brunches is intoxicating. It can make the chief executive officer of "NewCom" believe that he is a real "player" in the telecommunications marketplace and deserving of all of the deference that such a moniker might bestow. Even though NewCom's chief executive officer hasn't built a system, turned a dime, or even made more than a down payment to the FCC.

Those ego-driven tendencies are fueled by vice presidents, law firms, financial advisors and the like, who reflect these high-handed attitudes in dealing with local markets. There appears to be an expectancy that Joe of "Joe's Two-Way Shop" will be so awed when NewCom's representative calls, that Joe will drop everything and listen with rapt attention to every utterance from NewCom's representative. When Joe responds with, "Well, that's interesting, but I've got a repeater that's gone down on my site, so we'll have to finish this later," the carrier's rep is offended.

The exchange usually results in the NewCom's rep acting as though its agenda, its business, its build-out and its financial commitments are vastly more important than anything Joe might be doing (like earning a living by serving his customers) and that Joe is being unreasonable. Joe is not being unreasonable. He just isn't impressed. Good for him.

You see, Joe is making sure that his business remains profitable. Meanwhile, the large carrier's rep is trying to move NewCom toward profitability, and given NewCom's substantial debt, it'll be a long, long road. If you are worried about paying the rent, Joe's in better shape than NewCom, even though Joe couldn't find Wall Street with a map. Joe's got paying customers. NewCom has borrowed money and an untested idea.

What these new carriers have forgotten in most scenarios is that the carrier needs Joe more than Joe needs the carrier. NewCom needs space on Joe's tower to operate their system. The carrier needs experienced resellers and installers, like Joe. NewCom needs Joe's contacts. Joe needs to fix his repeater.

So, if your business is more like Joe's than NewCom's, consider the true leverage of the players involved. Joe can provide tower space, reselling services, installation, maintenance, and all of those necessary services that turn a business plan into a real telecommunications service providing profitable service to the public. Without the Joes of the industry, many NewComs will enter a new chapter in telecommunications history—Chapter 11.

The successful NewComs of the industry will be those that recognize the need for the Joes of the industry and who invite Joe to participate and add to their success. The losers (and there will be many) will be those who can't find their way from Wall Street to Main Street and who believe that Joe is only a tool instead of a potential partner.

To the Joes of the industry: Don't worry about the dogfight that is brewing and beginning between the industry behemoths. It will get awfully noisy for a while, but try to remain calm and look for relationships with carriers that will treat you and your business more like a partner and not like a patsy. The new carriers that will be left standing at the end of the fight will already be your friends. The losers will be those that thought they could do it without you.


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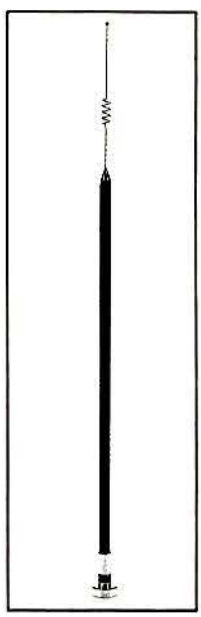
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# News

## WirelessNorth selects Motorola CDMA equipment for deployment of PCS in four North Central states



Installation of CDMA by WirelessNorth.

WirelessNorth, Plymouth, MN, has selected Motorola Pan American Wireless Infrastructure Division (PWID) to provision about $35 million in digital code-division multiple-access (CDMA) equipment to support a personal communication services (PCS) offering throughout the Midwest.

WirelessNorth will begin rolling out initial PCS sites mid-to-late 1997, offering wireless telephone communication to business and residential customers located in parts of North Dakota, Minnesota, Wisconsin and South Dakota. This targeted coverage area incorporates about 110,000 square miles and has a potential customer population of 2.4 million. This multimillion-dollar investment includes purchase and installation of Motorola's SC 604 and SC 601 compact CDMA radio base stations. A high-capacity EMX 2500 (electronic mobile exchange) mobile switch will also be deployed under this contract.

## Securicor group acquires control of Midland USA

Securicor Communications (Securicor), Surrey, UK, has acquired a controlling interest in Midland USA, Kansas City, MO, as the result of a transaction involving Midland's parent company and a Securicor subsidiary, Securicor Radiocomms (Radiocomms). Intek Diversified, Los Angeles, which owns Midland USA, issued stock to Securicor to purchase its Radiocomms subsidiary. Securicor received enough Intek stock to give it a controlling interest in Intek and, therefore, control of Midland USA. This type of transaction is known as a "reverse merger." Included in the transaction is indirect ownership of $10 million in preferred stock of E.F. Johnson, Burnsville, MN.

Securicor has agreed to lend Intek as much as $15 million to operate Intek's consolidated businesses, which include Midland USA's land mobile radio distribution business; the specialized mobile radio airtime services business of Roamer One, Torrance, CA; and manufacturing operations of Radiocomms.

Securicor's core businesses include security services, parcels and freight distribution, and fixed and mobile telecommunications, including a 40% interest in Cellnet, a UK cellular operator.

## AMTA statement approves release of 220MHz rules

The American Mobile Telecommunications Association (AMTA), Washington, DC, has welcomed the March 12 release by the FCC of new licensing rules for the 220MHz–222MHz wireless service.

The rules called for licensing remaining 220MHz spectrum on a geographic-area basis using competitive bidding. The association stated it is thankful that the Federal Communications Commission (FCC) chose to retain the current contiguous and non-contiguous channel allocations, providing incumbents and new entrants alike with a choice of service opportunities.

The association was disappointed by the FCC's decision to severely limit protection of existing operations, but stated that most provisions of the new rules appear to promise successful development of the spectrum.

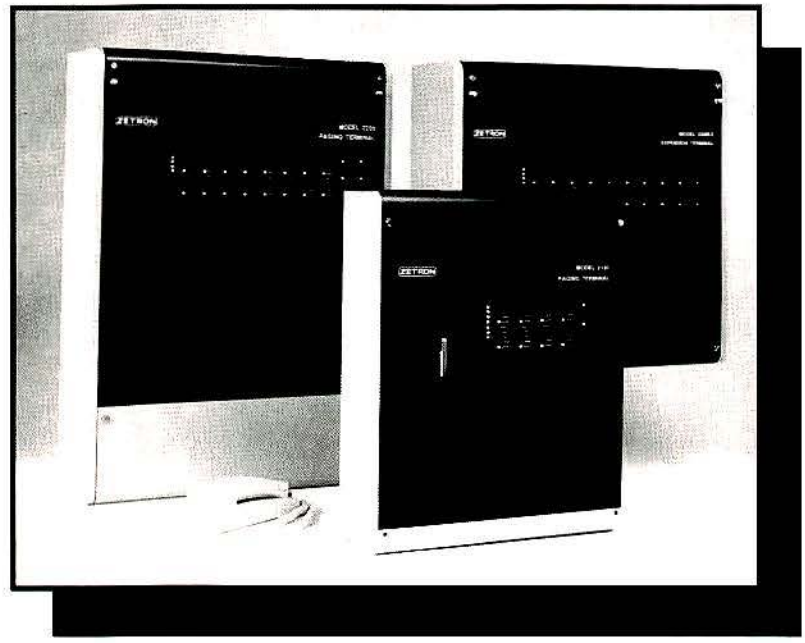
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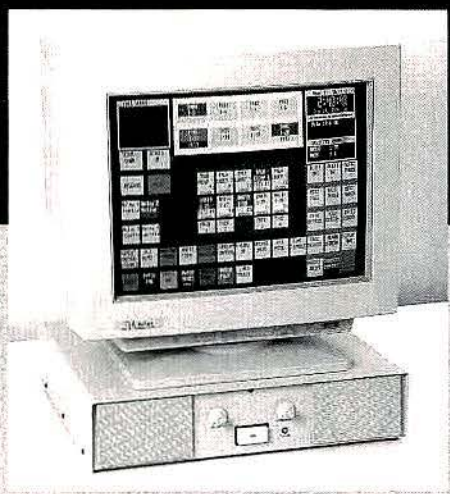
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# News

### Radio Club of America elects leaders for 1997

Members of the Radio Club of America, Union, NJ, elected officers and directors on Nov. 22, 1996. Raymond C. Trott, P.E., president of Trott Communications Group, Dallas, and the club's vice president in 1996, advanced to president by automatic succession. "With the new officers, the Radio Club of America is set to tackle long-range planning, expand membership services and increase its membership," Trott said. "1997 will witness the club's evolution to be the foremost club in the wireless and broadcast industries."

John E. Brennan, president of Activated Communications, New York, was elected as executive vice president. John P. Hart Jr., vice president of implementation, AT&T Wireless, Paramus, NJ, was elected as vice president.

Joseph S. Rosenbloom, a retired IBM attorney, Bluffton, SC, was re-elected as vice president/counsel. David E. Weisman, an attorney with Meyer, Faller, Weisman and Rosenberg, Washington, DC, was re-elected as vice president/co-counsel. Eric D. Stoll, Ph.D., P.E., senior staff engineer at Allied Signal, Teterboro, NJ, was re-elected as treasurer. Gilbert R. Houck, consultant, Houck & Bowen Engineers, New Cumberland, PA, was re-elected as secretary.

Directors who were elected on Nov. 22 include:

Don Bishop, editorial director, Intertec Publishing, Overland Park, KS (re-elected for two years).

Maxine Carter-Lome, principal, MCL Wireless, West Orange, NJ; and partner, Wireless Marcom, Morrison, CO (re-elected for two years).

John E. Dettra Jr., president, Dettra Communications, Washington, DC (re-elected for two years).

Archibald C. Doty Jr., investor, Fletcher, NC (re-elected for two years).

William E. Endres, president, Tele-Measurements, Clifton, NJ (elected for two years). Endres was the club's executive vice president in 1996.

Loren R. McQueen, president, Communication & Control, Campbell, CA (re-elected for one year).

Raymond Minichiello, founding chairman, Guglielmo Marconi Foundation, Bedford, NH (elected for two years).

Stanley Reubenstein, manufacturers' representative, Aurora Marketing, Aurora, CO (elected for one year).

Edward F. Weingart, vice president, AT&T Wireless, Hampstead, NC (re-elected for two years).

### FCC licenses Teledesic's 'Internet-in-the-sky'

Teledesic, Kirkland, WA, which is building a global, broadband "Internet-in-the-sky," has been granted a license by the Federal Communications Commission (FCC) to provide advanced, two-way telecommunications services via a constellation of low-Earth-orbiting satellites.

Teledesic said that it is the first satellite communications network approved by the FCC that will enable affordable, worldwide access to "fiber-like" telecommunications services such as broadband Internet access, video conferencing and interactive multimedia.

The license allows the company to build and to launch the Teledesic Network, as well as to make use of 500MHz of domestic radio frequency in the 28GHz band—the uplink portion of Ka-band—and a corresponding 500MHz of downlink spectrum. In July 1996, the FCC adopted a domestic band plan that designated that spectrum for primary use by non-geostationary fixed satellite services (NGSO FSS) such as Teledesic's.

This is the same radio spectrum the United Nations' International Telecommunications Union identified internationally for use by NGSO FSS at the 1995 World Radio Conference.



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# News

## Chadmoore Communications is awarded 41 license preferences

The Federal Communications Commission (FCC) has awarded Chadmoore Communications, a subsidiary of Chadmoore Wireless Group, preferences to obtain licenses for 41 additional channels in its southeastern United States operating area.

Chadmoore Communications, Las Vegas, also began operation in two additional markets that serve as links between Memphis, TN, and Little Rock, AR, which are existing service areas in the mid-South. The linking operations expand the service areas available to customers, enabling its customer base to use the company's service in travel over a larger geographic area.

The company has obtained marketing agreements in 10 markets in seven eastern seaboard states.

## *Rattler* publisher establishes World Wide Web home page

Merrill T. See, a Michigan radio communications equipment dealer and publisher of the *Rattler* newspaper in the 1980s, has established an electronic source of information in the form of a home page on the World Wide Web of the Internet. The site is intended to publicize "watchdog" activities on a variety of topics, See said, including the FCC. The Web site address is *http://www.geocities.com/CapitolHill/Lobby/1849.*

## PageNet launches advertising campaign for voice pager

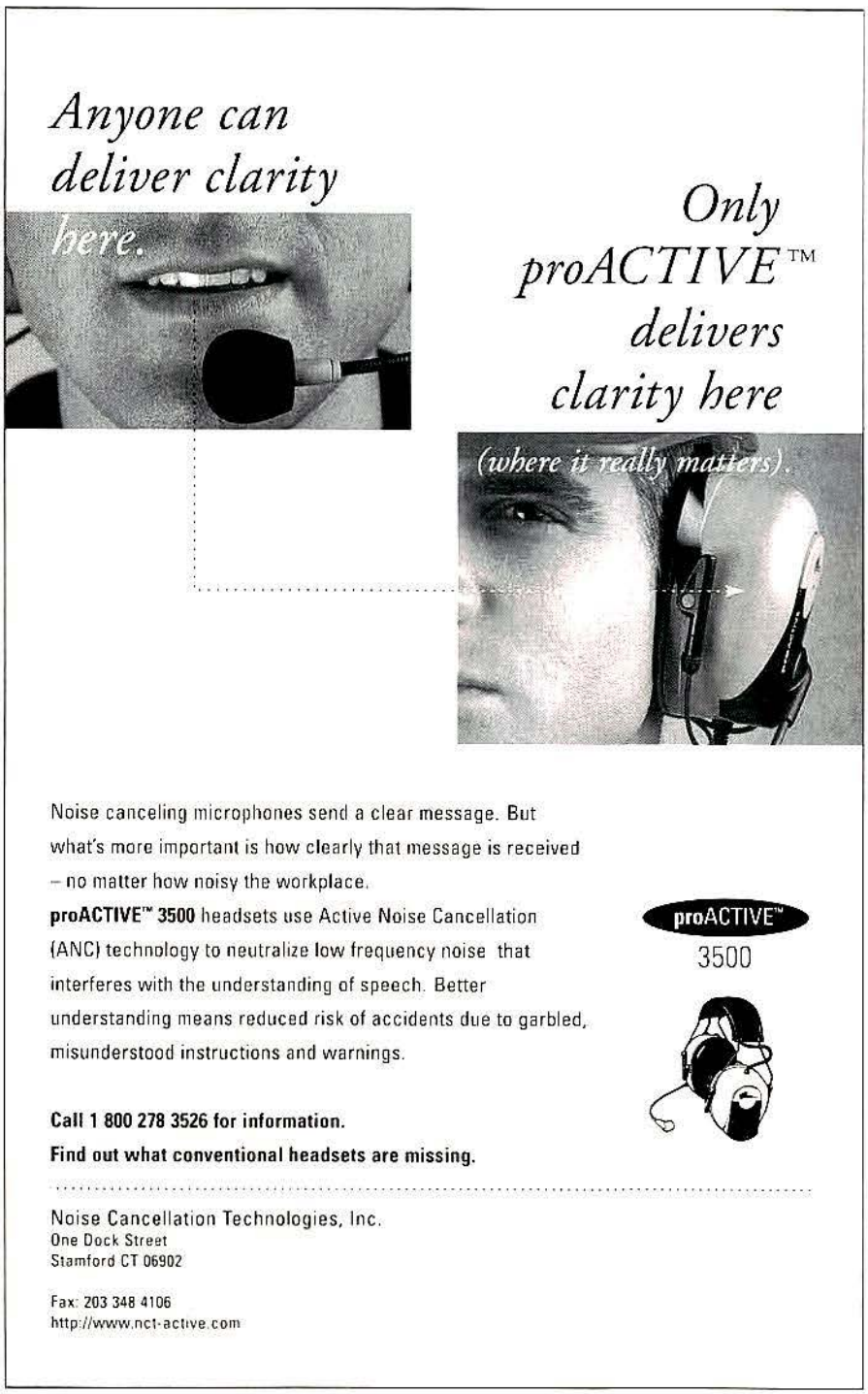
PageNet, Dallas, has launched a broad-based advertising campaign to support the introduction of VoiceNow, a voice paging service that is expected to have mass-market appeal among both consumer and business audiences. The multimedia campaign began in March with television, radio, local newspaper, regional print and outdoor advertisements in Dallas-Fort Worth, where the service debuted commercially in February. The campaign will expand to more than 50 metropolitan markets as VoiceNow is rolled out nationwide throughout 1997. Total spending is expected to exceed $20 million.

With VoiceNow—offered at rates as low as $4.95 per month for service—subscribers are able to receive voice messages that can be sent wirelessly to the palm-size VoiceNow pager from any telephone. The pager's push-button operation allows the user to play the message, rewind, fast-forward, control volume and more.

## RF Industries' Neulink division joins with Sonik Technologies

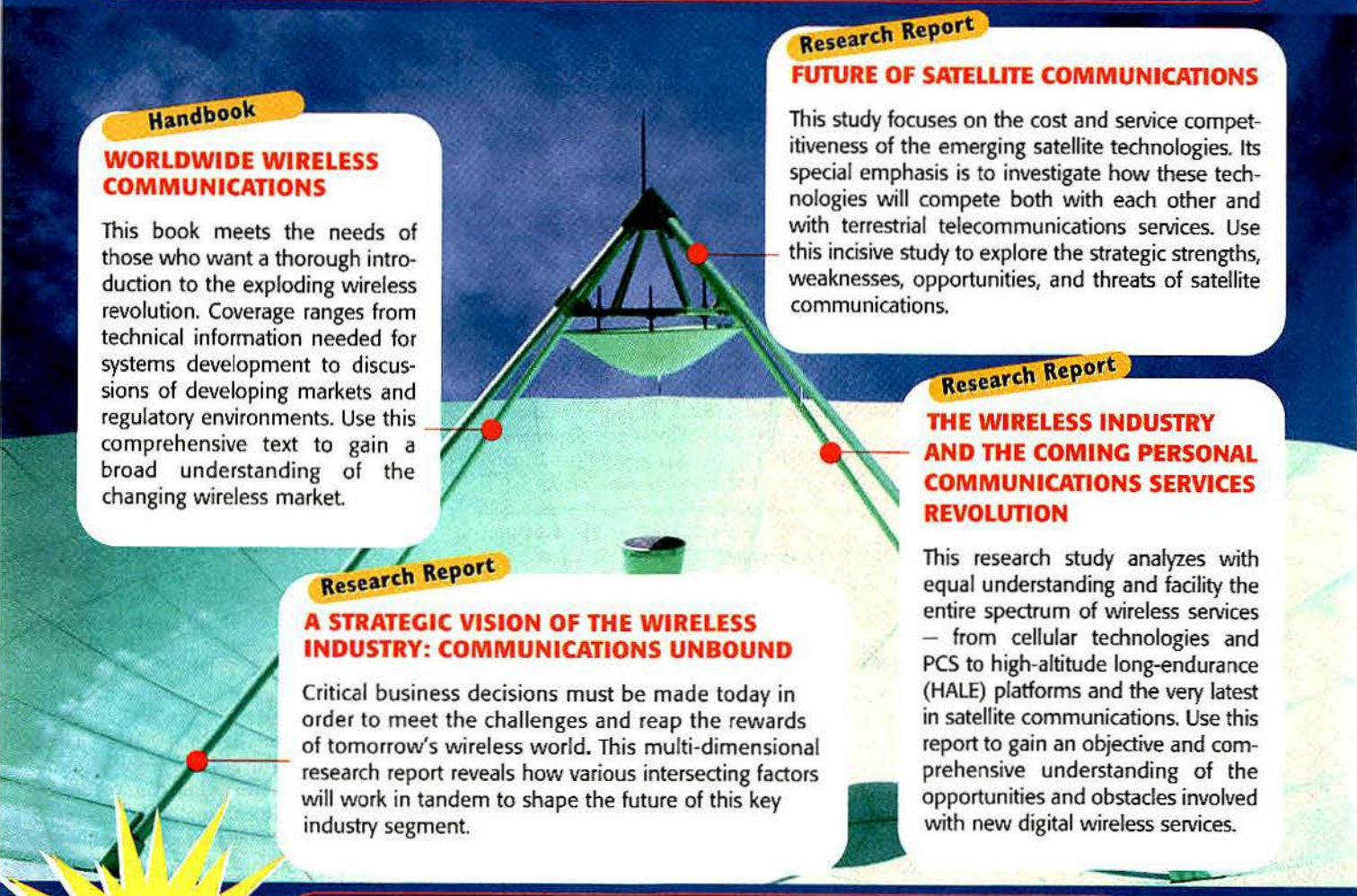
RF Industries' Neulink Division, San Diego, has established a strategic alliance with Sonik Technologies, San Marcos, CA, a privately held wireless products manufacturer.

"In recent years, Neulink and Sonik have often duplicated design and marketing efforts. This formalized relationship now enables Sonik to concentrate on the development of new products and Neulink to focus on its strengths in marketing and sales," said Kevin Slatnick, president of Sonik Technologies. "Currently, we are improving and adding features to Neulink's Neulink 9600 series of transceiver modems and our Skyline RTU, a miniature wireless data acquisition module. We are also developing a new digital paging exciter and advanced narrowband products for this fast growing segment of the wireless data market."

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## Readers' choice

Of all the new products and services in the September 1996 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

### Test receiver requires less than a second to sweep 30MHz to 2GHz




The Xplorer test receiver is a multipurpose nearfield communications test and surveillance sweeper that sweeps from 30MHz to 2GHz in less than one second. It automatically stops on any active frequency, demodulates the audio and displays the frequency of the transmitted signal. **Optoelectronics'** Xplorer decodes and displays subaudible signaling tones, including DCS, CTCSS and DTMF. The unit displays FM deviation and relative signal strength and operates in VFO mode for manual tuning to a specific frequency. As many as 500 data records can be stored in memory, as well as 1,000 hits per frequency. The Xplorer also locks on to two-way FM transmissions as far as 1/4 mile away. Features include CI-V-compliant serial data interface with both TTL and RS-232C levels, real-time clock and calendar with battery back-up, frequency skip button and tape recorder pause control relay jack.

**Circle (500) on Fast Fact Card**

### Waterproof VHF marine radio withstands high-velocity water impact

The HH 940 from **Uniden America** is a wearable waterproof, two-way VHF marine radio. Weighing 8.8 ounces, this radio can withstand high-velocity water impact as high as 50 mph, making it suitable to wear on a life jacket while participating in most water activities. The HH 940's construction protects against harsh marine conditions and reduces the possibility of saltwater corrosion. The radio features a waterproof key pad, all-channel scan, a flexible antenna and a backlit LCD. The HH 940 is equipped with all U.S. and international marine channels and incorporates a triple watch feature, allowing users to continually observe emergency channels 16 and 9 while monitoring a third channel. Users may also simultaneously activate the weather alert feature, which periodically refers to the NOAA weather service to monitor inclement conditions.

**Circle (351) on Fast Fact Card**

### Coaxial surge protectors act quickly to ground lightning




**Citel** has added a new line of coaxial surge protectors for microwaves, radios, antennas, GPS and satellite systems. The surge protectors provide quick protection against lightning surges and electrical transients. The coaxial surge suppressors use a fast-acting gas tube technology that makes the suppressors usable for broadband applications. Connectors offered include N, BNC, TNC, SMA and 7/16. Citel P8AX coaxial protectors are available for any power from 1W to 1,000W and any frequency from dc to 10GHz. The protectors feature low VSWR and insertion loss. Grounding can be done either through an external ground screw or through a bulkhead mount. Maximum capacitance is 1pF. The protectors mount as a cable assembly or through the chassis of the equipment to be protected.

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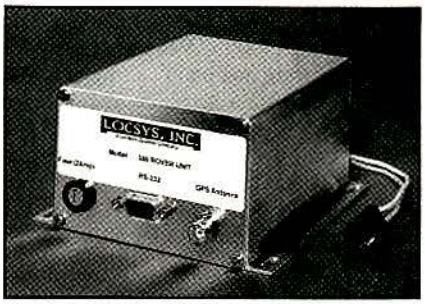
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### Vehicular tracking system allows over-the-air programming




**Locsys'** vehicular tracking system, the 386 Rover unit, allows fleet managers to perform over-the-air programming of embedded vehicular controllers using preset parameters. Locsys incorporated Flash ROM in its new GPS tracking device to provide this feature. The unit has an Intel 386EX embedded microprocessor and GPS tracking receiver. Users can trigger certain events such as speed and distance to appear on the host computer screen simultaneously with the event. The 386 Rover unit, which works off any RF link, can become a wireless node on a user's Intranet or the Internet. The compact unit has automatic shut-off to prevent draining low battery sources. A build-in 1200 baud RF modem is available.

**Circle (353) on Fast Fact Card**

### Rechargeable battery replaces NTN 7147 for Motorola radios

**JBro Batteries'** JB 7147 is an intrinsically safe 7.5V, 1,500mAh, rechargeable replacement battery for Motorola radio models MT 2000 and GT 1000. The battery is a direct replacement for the Motorola NTN 7147. Factory Mutual-approved, the JB 7147 is suitable for use in oil and gas, automotive painting and other industries requiring special safety precautions. This battery has been approved as non-incendiary for Class 1, Division 2, Groups A, B, C and D hazardous locations.

**Circle (354) on Fast Fact Card**

### Mobile data terminal works with various peripherals

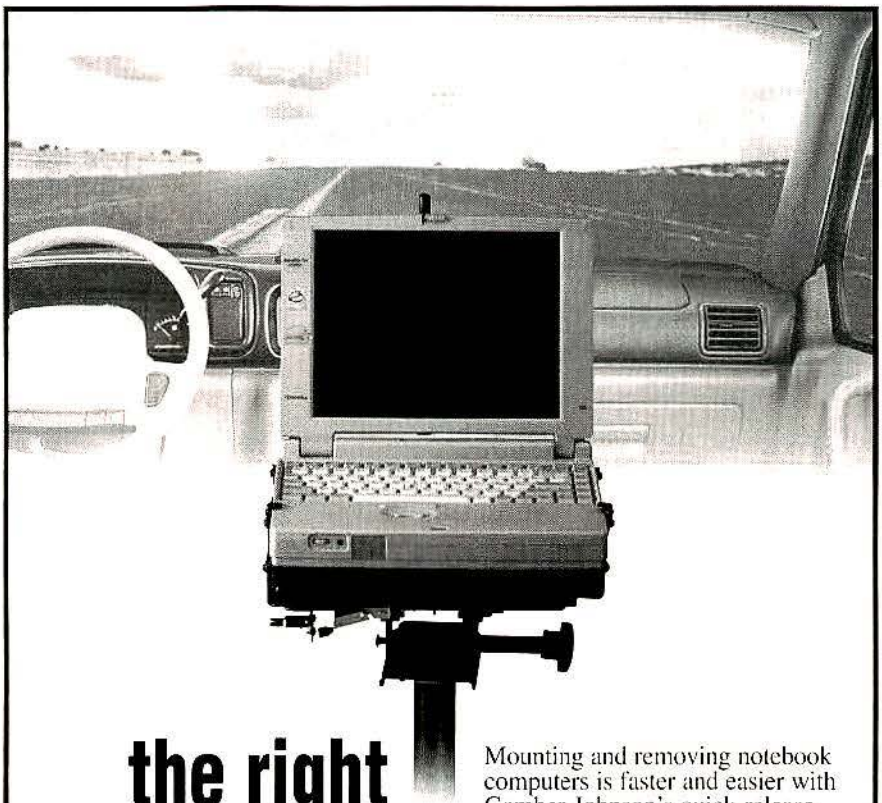
The Q100 mobile data terminal and Omni-Dispatch software from **Omni-Provincial Electronics (Data Division)** is available with or without an internal modem. The Q100 can be used with a card reader, GPS receiver or serial printer. The PC software runs in both Windows 3.1 and Windows 95 environments.

**Circle (355) on Fast Fact Card**

### Mobile radio features 396 channels and built-in theft protection

**Tad Radio's** M10 mobile radio features 396 channels, a small size, built-in theft protection and an alphanumeric display. The display can be dimmed if required, and the buttons are backlighted. The M10 operates from 138MHz–174MHz without retuning. The mobile is PC-programmable and can be cloned. Standard features include CTCSS and DCS tone signaling, 3W internal speaker, 30W RF output power, low and normal receive sensitivity switch, quick channel access with a rotary switch and busy-channel lockout available on a per-channel basis. The radio also maintains all the previous M8 features. Custom software is available on request.

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Circle (74) on Fast Fact Card


## *New products*

### Light control and card access system secures sites

The TSM2000 light control and card access system from **Hark Systems** offers both card access and remote monitoring, which eliminates constant keying at sites. Versatile light control features include seasonal timing and photocell monitoring. Tower light status, dim lights and other alarm conditions such as "door open" and telephone line outages are available. The central site monitor software allows viewing of all activity at the site, including all access. Detailed logs of events such as open doors, power outage and temperature combine with the card access system for secure, tamper-proof, controlled access to the site.

Circle (357) on Fast Fact Card

### Entrance panel provides equipment protection

**PolyPhaser's** eight-port entrance panel (8PEP) diverts lightning energy to earth. Engineered to provide single-point grounding for as many as eight coaxial cables from 1/2" to 1" in diameter, the 8PEP is a compact, high-density panel. The unit is complete with cone-shaped weather boots and multiple copper down-conductors terminating to a buried sandwich ground bar providing a low inductance path to ground. The 8PEP assures proper mounting and grounding for both the coax shields and PolyPhaser's coax protectors while ensuring weathertight cable penetrations. Panel dimensions are 12" high by 17.25" wide, with installation configured for standard 16" on-center studs.

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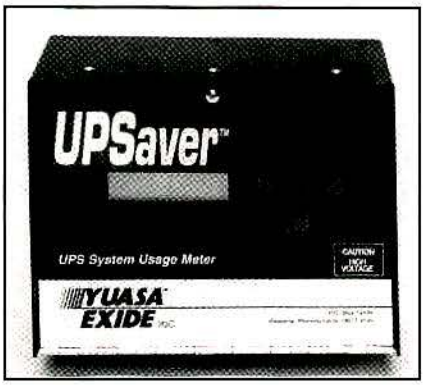

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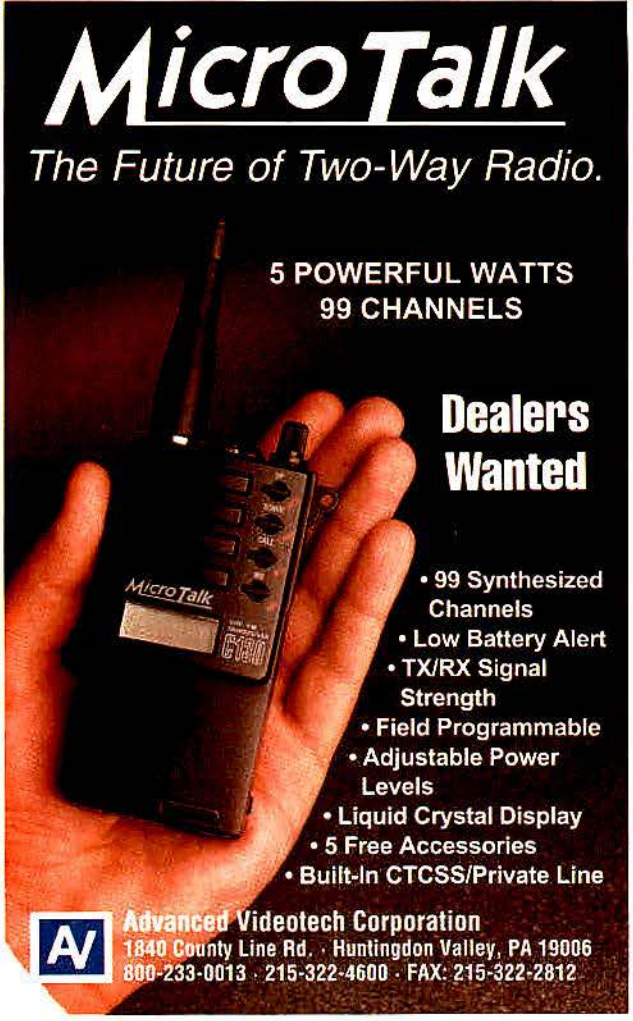
**Usage meter for uninterruptible power supply battery records use information for retrieval**




**Yuasa-Exide's** UPSaver is a system usage meter for uninterruptible power supply (UPS) applications. The UPSaver provides a complete range of valuable information for system operators. The device records the start time, date and duration of a power interruption and assigns the event a sequential identification number. It records and, on command, plays back a complete UPS battery usage history of as many as 50 specific UPS events. This information can help determine battery usage and maintenance, UPS payback and capital expenditures. A user-friendly, two-line, 20-character LCD and simple controls allow users to scroll through all memory-stored information. The UPSaver operates on 120Vac/60Hz, and it has its own dc battery backup for two-hour support in case of ac failure.

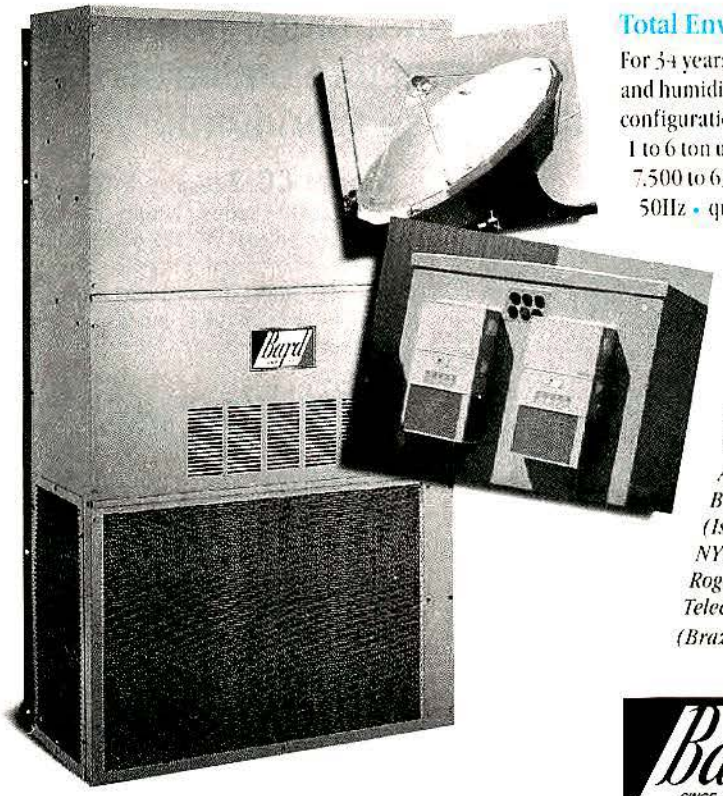
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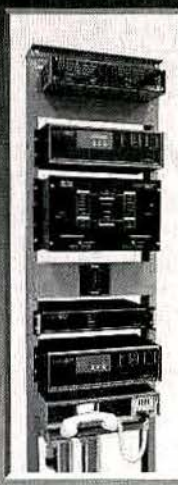
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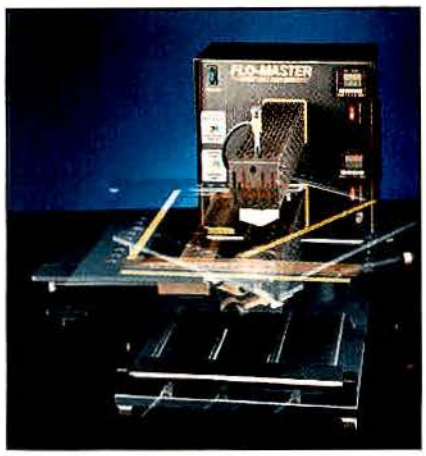
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Circle (78) on Fast Fact Card


## *New products*

### Unit reworks large components on multilayer boards




The Flo-Master from **A.P.E. (Automated Products Equipment)** has been designed to complement the A.P.E. Chipmaster ball grid array (BGA) system in handling and supporting larger work areas and to provide pre-heat to prevent potential warping of these larger and often lower profile board types. The technology of the Chipmaster has been adopted in the design of the Flo-Master, providing a 1,200W heat source and reducing the necessary operating temperature. The Flo-Master administers the necessary calorific energy for component and board mass absorption to remove and to replace components. The larger board holder will accommodate boards up to 24" by 30", and the bottom heater will bring the area to be reworked to a constant noncritical temperature, by a digital integrated controller (DIC).

Circle (360) on Fast Fact Card


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**Model LT-2** Displays LTR® User ID, repeater number and DTMF which are also exported on rear panel RS-232 port. Optional LT-2P application program shows all repeater activity for users homed on repeater being monitored, usage graphs and more. LT-2 looks similar to CD-2 pictured.

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**FAX** (805) 642-7271

**Email** sales@connectsystems.com
**Internet** www.connectsystems.com

Circle (79) on Fast Fact Card

### UHF 40W mobile radio operates in three modes



The 9840-2 UHF mobile radio from **E.F. Johnson** operates in LTR trunking, conventional or talk-around modes, and delivers as many as 40W of RF power with 25kHz or 12.5kHz narrowband operation. The 9840-2 features a large, bright display, knob controls, programmable function keys and a front-firing speaker.

**Circle (361) on Fast Fact Card**

### Hoisting grip speeds coaxial cable installation

**Andrew's** support and hoisting grip for its Heliax coaxial cable promotes rapid and safe cable installation. A clamp attaches to the bottom of the grip. The clamp is then crimped with a specially designed crimping tool. The efficiency of the clamp allows the grip to be used as a support mechanism as well as a hoisting device. Once the cable is in position and the grip handle is fastened to a tower member, the hoist line can be removed. The hoisting grip kit comes with a support clamp. A special crimp tool and additional clamps are available separately.

**Circle (362) on Fast Fact Card**




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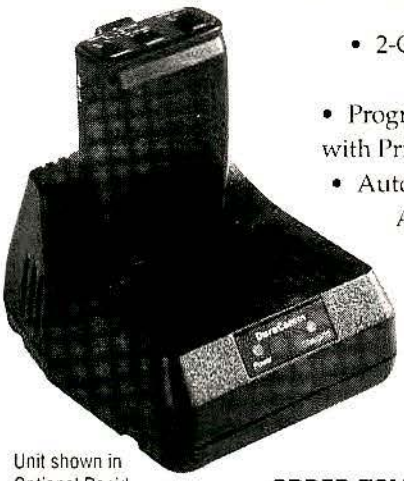
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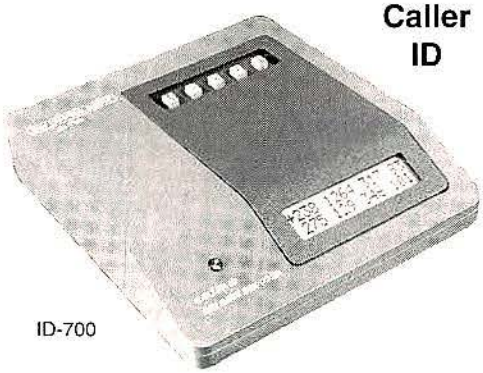
### Cable kit contains versatile and flexible cable assemblies

**RF Connectors'** Unicable kit allows the user to mix and match any combination of connectors or adapters to the ends of a 48" cable assembly. Covered in a soft, PVC matte blue jacket with matching blue, molded strain reliefs, these cable assemblies are flexible and easy to handle. This extra-flexible RF-58A/U-type 50Ω cable with 95% double shielding (tinned copper braid over aluminum foil) is 48" long. Unidapt universal connectors at each end feature machined brass, silver-plated bodies, gold-plated contacts and Teflon dielectric insulators. The frequency range is dc 50 to 1GHz; impedance: 50Ω; insertion loss: <.2dB; and VSWR max 1.2:1 (dc to 1.5GHz).

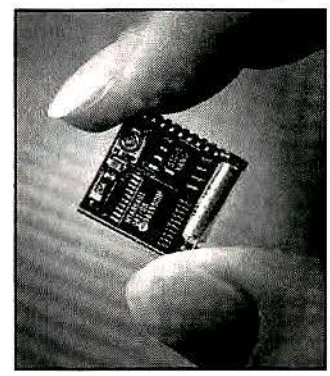
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ID-700



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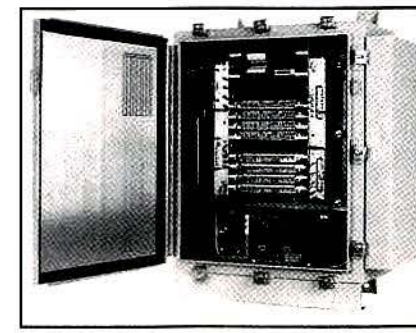
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**Circle (84) on Fast Fact Card**


### CDMA repeater extends coverage for in-building applications



**Allen Telecom Group's** EAC-800 CDMA repeater provides service in problematic coverage areas, such as tunnels, arenas, convention centers, airports and parking garages. It also improves coverage in larger buildings, such as hospitals, apartments and office towers. The EAC-800 is a digital repeater that picks up the downlink signal from an existing CDMA base station, amplifies it and retransmits it to the desired area of coverage. Simultaneously, the repeater receives uplink signals from the handset, amplifies them and passes them on to the base station receiver over the same link. In effect, the repeater decreases the propagation path loss to the handset while keeping the signal contents and waveform intact.

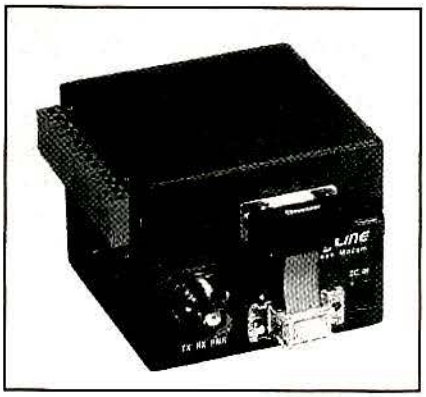
**Circle (364) on Fast Fact Card**

### Monitor fights paging traffic overload, flags probable abuse

**Real Time Strategies** (RTS) has added the Load Sentry to the Advantage family of radio paging infrastructure products. Available as a plug-in enhancement to any RTS Advantage product, or in a self-standing messaging gateway—permitting access from all types of services—Load Sentry monitors incoming traffic to guard against traffic overload and system abuses, by identifying and controlling the following: traffic trends and abrupt changes in calling patterns, messages of excessive length, an unusual number of messages entered from any source and an unusual number of messages sent to any subscriber. Load Sentry's configurable parameters allow system managers to define normal traffic in both peak and off-peak times Traffic found to violate these established norms can be flagged for administrator intervention, trickled out to prevent instantaneous overload, segmented into multiple transmissions and deferred until off-peak periods.

**Circle (365) on Fast Fact Card**

### VHF SCADA transceiver simplifies remote data acquisition



The SkyLine-RTU from **RF Neulink** is a supervisory control and data acquisition device. Each RTU is a fully integrated subsystem that includes a VHF radio transceiver, RS-232 modem interface and a digital/analog, I/O board, in a 3"×3"×2.5" stainless-steel enclosure. The standard device provides for eight opto-isolated digital inputs and outputs and two analog-to-digital converter terminals. As many as eight I/O modules can be stacked, providing a combination of as many as 64 digital I/O and 16 A/D terminals. Optional RTU modules available with eight-channel I/O for current, an analog I/O module with 12-bit resolution and two channels in and out, and four- and six-channel relay output ports.

**Circle (366) on Fast Fact Card**

### Direction finder tracks cellular phones with graphic map display

The Locator MDF mapping direction finder from **Communications Test Instruments** (CTI) features a real-time display of the tracking vehicle and bearings to a target cellular phone superimposed on a moving map display. Map detail is presented in a North-up format and is shown to the street level for all areas of the United States. Cell sites and other pertinent information may be entered and customized by the user. The Locator MDF is designed for use in a mobile environment. The most frequently used functions are accessed by hot-keys. The user can quickly and easily locate cellular phones using the graphic map display. The AutoTrack feature maintains the tracking vehicle position and bearing within the current display window. The Locator MDF is compatible with the Locator XP Plus System and can also be used with other competitive cellular intercept systems.

**Circle (367) on Fast Fact Card**

### Pager offers long battery life, variety of melodies and colors

The Cobalt Flex protocol pager from **Philips Consumer Communications** (PCC) is a fully featured numeric unit with a large, top-mount display. Cobalt offers a long battery life (25 weeks on a single AAA battery) and a light weight of two ounces for this type of pager. The choice of nine tones or melodies and five colors makes it easy to personalize. Cobalt features alarm and message time-stamping, a voice-mail icon and a 12-digit display. The pager also can store as many as 32 messages with a maximum message length of 20 digits each. With three easy-to-use buttons, Cobalt has been streamlined to make it more intuitive and user-friendly.

**Circle (368) on Fast Fact Card**


TAD Radio

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It's here... the new TAD M10

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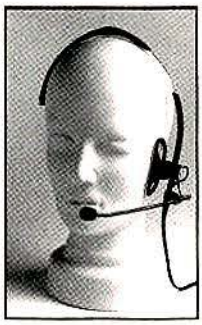
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Circle (86) on Fast Fact Card

### Lightweight vibration headsets protect hearing from ambient noise



Lightweight vibration headsets from **CeoTronics** replace traditional high-noise earmuffs, which can be hot, unhygienic and generally uncomfortable to wear in many industrial environments. Lightweight vibration headsets use a small telecommunications-type headband with a noise-canceling electret microphone. The headband is designed with a special earloop that is used in combination with noise-attenuating foam earplugs for hearing protection. A vibration "speaker" vibrates radio audio directly into the user's head via the earloop for clear reception. The headset has radio interfaces available for more than 300 international makes and models.

**Circle (369) on Fast Fact Card**

### Installation kits allow operators to remove indoor coverage nulls

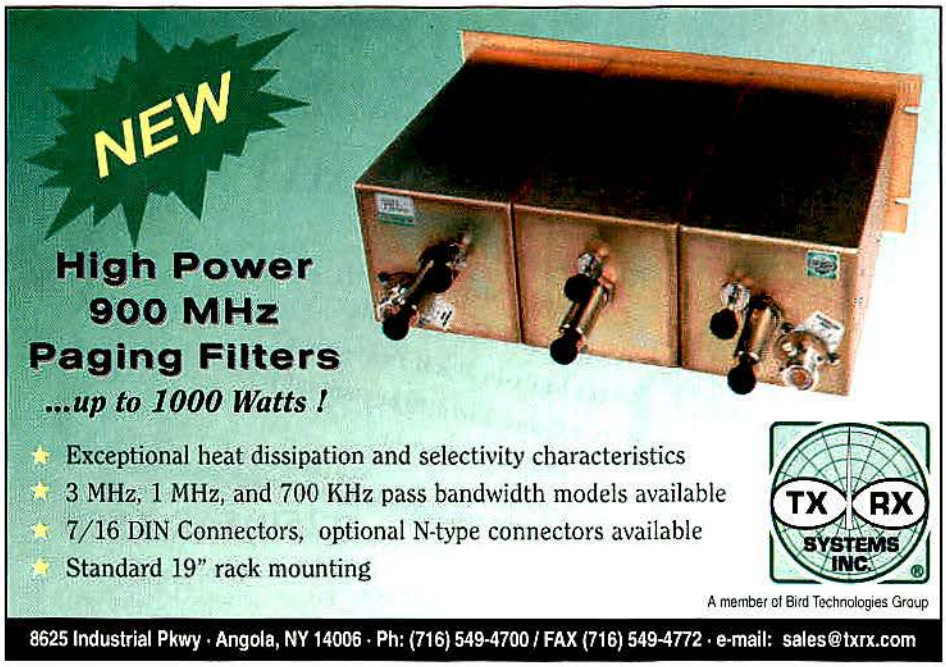
Two null kits from **Andrew** contain all the necessary components for improving indoor cellular coverage. These installation kits allow cellular operators to eliminate nulls in inside areas such as kiosks, restaurants, offices and parking areas. The kits contain all the antennas, amplifiers, cables and mounting hardware needed to extend coverage to specific indoor areas. Kits are available in two versions: the Kiosk Null Kit extends RF coverage into small areas within shopping centers, mall locations or office buildings, and "kiosk-type" shielded locations such as guard booths, security personnel shelters and industrial process control rooms. The Moderate Building Null Kit expands RF coverage in larger areas such as restaurants, small warehouses and offices.

**Circle (370) on Fast Fact Card**

### Paging filter series protects single- or multi-channel transmitters

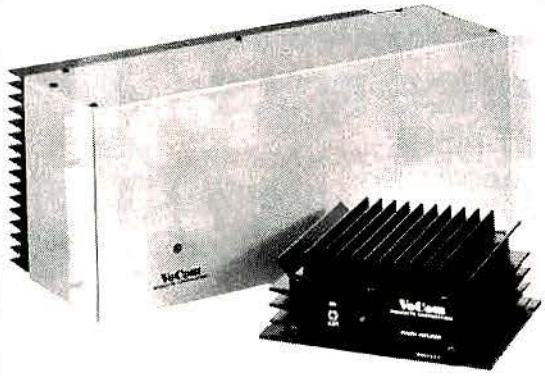
**PolyPhaser** has engineered a paging filter series to protect single- or multi-channel transmitters in the 890MHz–980MHz bandwidth. The paging filter series contains no gas tube and is available in multiple connector configurations. The devices are dc-blocked to provide maximum equipment protection. PolyPhaser's model IS-PF50HN is rated at 750W single channel with a VSWR of ≤0.1dB over the frequency range. Throughput energy is 10μJ at 8/20μs waveform.

**Circle (371) on Fast Fact Card**


Visit us at IWCE, Booth #631

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Circle (88) on Fast Fact Card

### Weather radio transmits severe weather alerts to two-way radio system

**Thunder Eagle's** Weather Eagle 300 is a NOAA weather radio (NWR) scanner, recorder and communication system interface. The radio selects the strongest of seven NWR channels having audio using patented Smartscan technology. It digitally records and date- and time-stamps 90-second severe weather warnings into the Weather Eagle receiver. Severe weather alerts are automatically transmitted on a two-way radio system without interfering with communication in progress. The Weather Eagle gives DTMF remote control access to last warning and live weather over a two-way radio system and through a telephone system. It automatically sets off a pager and places severe weather warnings on a telephone and voice mail. It has a standard 19" rack mount.

**Circle (372) on Fast Fact Card**

### Mobile data terminal supports GPS, credit card readers

**CES Wireless Technologies'** Tracker family of mobile data terminals features intelligent messaging capabilities with automatic vehicle location that works with an existing mobile radio system. The Tracker features an integral modem for direct radio interface. The units are enclosed in a rugged enclosure and sealed to protect from dust and the harsh environment that these devices are normally installed in. Two models are currently offered: The Tracker II is an advanced status reporter; the Tracker III has additional programmable keys and an LCD. Both models support GPS, credit card readers, bar code scanners, printers and engine management interfaces. All transmissions are automatic using the CES Quadtec process that automatically takes control of the radio to properly determine when the channel is available, send the message and receive the acknowledgment. It retries if the data is not properly received. If the vehicle is out of the coverage area, the Tracker automatically stores the message in memory until the vehicle is back within the radio coverage area. No driver action is required.

**Circle (373) on Fast Fact Card**


## Remote Control for your Kenwood Radio



TK630
TK730
TK830
TK930/931
TK840
TK940/941

The Alpha series MCR/TSR remotes and MCP/TSP series termination panels allows you to remote control your Kenwood conventional or trunking radio over any two wire voice grade circuit.

The Alpha series remote provides an LCD readout for channel number, up to 99, and a ten character channel name. Controls also include channel up and down, monitor, scan and privacy. All parallel remotes and the radio are updated simultaneously any time a change takes place.

Systems also available for Motorola, Midland and Johnson radios.

**Features**

- Simple installation - No soldering, cutting or crimping.
- Provides remote channel indication.
- Programmable ten character name per channel.
- Programming done via front panel.
- No special cables or PC required.

CPI

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**Circle (89) on Fast Fact Card**



## PolyPhaser Corporation



POLYPHASER CORPORATION HEADQUARTERS IS LOCATED IN THE CARSON VALLEY

Nestled in the Carson Valley and just minutes from Lake Tahoe, PolyPhaser Corporation and its 140 employees are headquartered in Minden, Nevada. The company is dedicated to providing lightning/electromagnetic pulse protection and grounding solutions for the communications industry. Founded in 1979 by Roger and Gayle Block, PolyPhaser designs and manufactures more than 2,500 models of coax, power and twisted pair protectors from within a 53,000 square foot state-of-the-art facility.

PolyPhaser custom designs products to meet customer needs in a variety of fields, including cellular, paging, broadcast, wireless, mobile communications, military, PCS, GPS, 9-1-1 sites, ham radio and power companies. Custom protectors are routinely designed, tested and produced, and often become part of PolyPhaser's future catalogs.

Among PolyPhaser's lightning protection products are coax entrance panels, cellular protectors, in-line power mains, global positioning system coaxial protectors, shunt-type power mains, rack panel protectors, educational material, LAN/data line protection, custom products, grounding components and power-supply protectors.

To further safeguard a client's communications equipment, PolyPhaser offers complete technical support, testing, training, consulting and a web site at http://www.polyphaser.com.

A current seminar PolyPhaser is offering consists of three eight-hour days. The first day addresses lightning and grounding fundamentals; day two discusses grounding theory, applications, methods and products; and day three delves into grounding case histories and offers hands-on learning activities.

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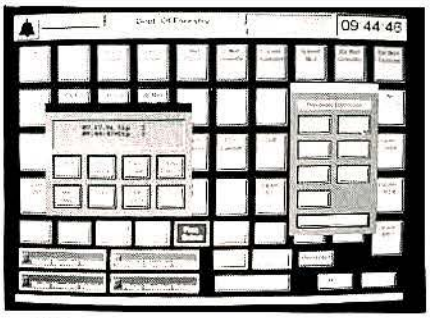
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**Circle (90) on Fast Fact Card**

# The new ULTRA-COM NT Windows NT-Based

**Radio Dispatch System**



Moducom's new Windows-based ULTRA-COM NT is the only communications workstation that lets you design screens and set operating parameters with no changes to software and with no reprogramming costs, using MODUCOM's exclusive *Screenmaker* and *Customizer* programs.

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The ULTRA-COM NT's design, whether stand-alone or as part of a multi-position system, takes advantage of the latest advances in communications technology.

**Moducom Windows NT-based dispatch consoles, are designed for today's emergency communications requirements, and for the future.**

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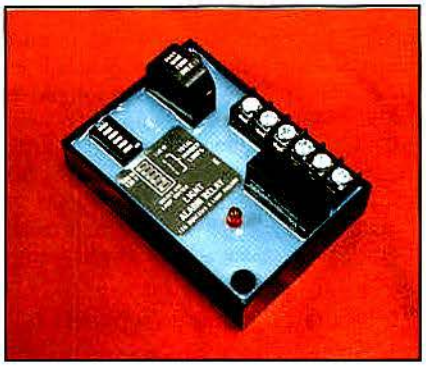
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Circle (91) on Fast Fact Card


# *New products*

## Lamp alarm relay meets most obstruction lighting requirements



The SCR630T from **SSAC** is a universal electronic lamp alarm relay used to sense a lamp failure on radio and TV towers and other tall structures. One unit can be adjusted to meet most obstruction lighting requirements. The SCR630T will detect the loss of one lamp out of one, two, three or four lamps. As many as four 500W flashing beacons or as many as four 100W (116W) side lamps can be monitored with one unit. Selection of the number of lamps, wattage and their voltages are made via six switches on the unit. The SCR630T's toroidal transformer constantly monitors the current flowing in the lamps' wiring. When the current drops because of a lamp failure, the SCR630T's LED lights and its output transfers. A trip delay is included to prevent nuisance tripping.

Circle (374) on Fast Fact Card

## Switching regulated converter designed for use on construction equipment

**Translectic's** Service-Mate switching regulated converters (SM2412) are heavy-duty dc-to-dc converters with extended input ranges. They are designed for use on 24V, 36V and 48V construction equipment or lift trucks that use standard 12V lights, radios, cellular phones, two-way radios and computers. The converters are weatherproof, vibration-resistant and thermal protected. The SM2412-25 features chaos shutdown, 25A continuous output current, undervoltage lockout and minimum and maximum input logical shutdown.

Circle (375) on Fast Fact Card


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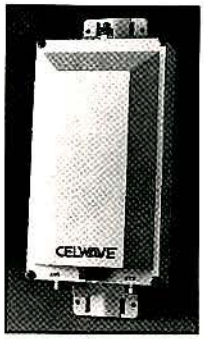
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Circle (92) on Fast Fact Card

### Towertop amplifier features a low-noise figure




The ATM192012 towertop amplifier from **Celwave** provides extended base station coverage by reducing the overall system noise figure. The use of the amplifier can potentially reduce the required number of sites by as much as 40%, depending on site noise and cable run lengths. The Celwave towertop amplifier features a low-noise figure of 1.8dB for improved receiver performance. Because the uplink signal is improved, portable battery talk time can be extended as well. The unit's compact size makes it easy to conceal behind the antenna and to blend into the surroundings.

**Circle (376) on Fast Fact Card**

### Speaker microphone offers weatherproof operation



**TwitCo** is distributing ParMarLow Labs' model SM-1120 speaker microphone for Uniden radio. The mic provides lightweight, rugged and weatherproof service for Uniden models SPH, SPU and SPS. ParMarLow Labs speaker microphones feature audio accessory jacks and rotating clothing clips.

**Circle (377) on Fast Fact Card**

### GSM mobile tester series offers tester for every phone

**Wavetek's** 4100 series of global system for mobile communications (GSM) phone testers offers the right tester for every cellular phone system in accordance with GSM specifications. Models in the series have a compact design. Each tester is fitted with VLSI chipsets and digital signal processors. Menu-driven user guidance, an uncluttered keypad and an integrated help function simplify testing for applications such as point-of-sale.

**Circle (379) on Fast Fact Card**

### Cabinet line provides insulated space for installation

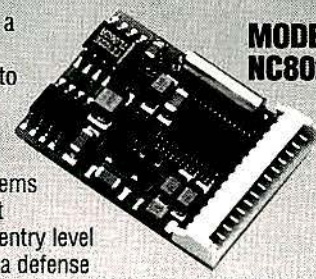


**Enviro-Buildings** has added an insulated cabinet line to its existing line of communication shelters. Enviro's new cabinets bring with them the features of the existing line of buildings such as cam-action locks, modular panels and three-inch or four-inch structural foam insulation sandwiched between sheets of 26-gauge and 20-gauge painted galvanized steel. In addition, the new units come in varying cabinet sizes and can be ordered to the customer's specific request. The new cabinets come standard with two sets of double access doors, one on each side of the unit to allow for easy access for service and modification of equipment in the field. The units come with HVAC systems, or the HVAC system may be supplied and installed by the customer in the field. The cabinets can be assembled and shipped with the electronic equipment and batteries installed or assembled on site in a minimal amount of time.

**Circle (378) on Fast Fact Card**


# VOICE SECURITY ENCRYPTION

The Model NC802 is a miniature inversion scrambler designed to provide intermediate level security for two-way radio voice communication systems and is a perfect, cost effective solution to entry level voice scrambling as a defense against unauthorized or casual listeners. The NC802 provides eight user selectable carrier codes commonly used by other manufacturers and interfaces easily to most radios with near transparency to the user.



**MODEL NC802**

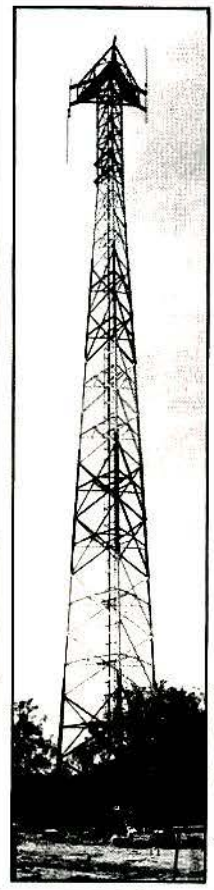
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Circle (94) on Fast Fact Card

# How To Tell If Your Base Station Needs A Newmar Power- Pac ... Pull the Plug.




If your communication system dies when you have an interruption in AC power, you need the NEWMAR Power-Pac. It's a 20 amp power supply with a built-in back-up battery which acts as an uninterruptible DC supply when AC power is down.

The Power-Pac's sealed deep cycle 7 amp/hour battery is normally floated at full charge by the supply. If AC power is interrupted, the battery automatically takes over powering the radio. This assures your communication system is up when it is needed most– during a power outage.

Power-Pac, when operating on battery back-up can power a 25 watt radio for up to two hours, based on a 20% tx/rx duty cycle. Indicators on the front panel alert the operator to system status.

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**Circle (96) on Fast Fact Card**


# Literature

## Brochure highlights power meters

**Boonton Electronics**' color brochure outlines high-performance power meters. The six-page brochure provides complete specifications and applications of Boonton Electronics' model 4230, as well as highlights of the model 4220 and model 4300 power meters and model 4500 digital sampling power analyzer. The model 4230 performs high-speed measurements and features a wide 90dB dynamic range, as shown through text, photography and graphics. Integration into ATE production testing applications is also outlined.

**Circle (451) on Fast Fact Card**

## Catalog offers debugging tools

**Hewlett Packard**'s new 24-page catalog highlights prototype debugging tools. The *HP Digital Design and Debug* catalog, aimed at software and hardware engineers, firmware designers and systems integrators, covers HP logic analyzers, emulators, processor probes, mixed-signal oscilloscopes and PCI-bus verification tools.

**Circle (452) on Fast Fact Card**

## Guide describes telemetry monitoring systems

The *1997 Resource Guide*, from **DPS**, includes a description of each DPS product, with an overview section at the front. The section provides a quick look at network monitoring and shows examples of how DPS products such as alarm system masters and remotes, modular alarm systems, remote access workstations and test sets, can be used to satisfy a variety of applications. The 47-page catalog includes two postage-free response cards for requesting further product information.

**Circle (453) on Fast Fact Card**

## Brochure features RF coaxial connectors

A brochure that features a full range of standard and custom RF coaxial connectors and cable assemblies for RF power, wireless, digital RF, test and manufacturing applications is offered by **Tru-Connector**. The "RF Coaxial Connectors" brochure features photographs and descriptions of 7/16 series connectors including plugs, jacks, receptacles, combinations and adapters; quick-disconnect types corresponding to LC, C, SC, BNC and TNC connectors; and SQ "super quick" quick-change connectors for high-power applications. Other quick-change RF connectors with a consistent QC end for use with high-power testing and monitoring equipment are included in the 12-page color brochure.

**Circle (454) on Fast Fact Card**

## Research reports on status of wireless location services

New primary market research is available from **Strategis Group**, formerly MTA-EMCI, concerning the demands for wireless location services. *Wireless Location Services: 1997* reports on the demand for location-based information services among consumers and business professionals, applications sought by wireless users and non-users alike and how much wireless communications users are willing to pay for location-based information services. According to the research, wireless location services will see a surge of activity in 1997 and 1998 due to initiatives from location monitoring service (LMS) licensees (902MHz–928MHz) and industry reaction to the FCC's E9-1-1 ruling.

**Circle (455) on Fast Fact Card**

# People


Hamer


Bocklund


Rohde


Bobetsky

Changes at E.F. Johnson, Burnsville, MN:
**Fredrick G. Hamer,** vice president of sales, advances to vice president of both sales and marketing.
**Scott R. Bocklund,** vice president, finance and chief financial officer, moves up to president.

**Tom Wineland,** vice president of Kenwood Communications, Long Beach, CA, advances to president.

**Monty Rohde,** engineering manager at Centurion International, Lincoln, NE, becomes plant manager of the battery division.

**John Bobetsky** departs Dorne and Margolin, New York, as vice president of commercial sales and marketing to join IFR Systems, Wichita, KS, as director of business development, test and measurement products.

Promotions at Ardis, Lincolnshire, IL:
**Mark Baker**, senior staff accountant and controller, moves up to chief financial officer.
**Michael McGee**, director of client services, advances to vice president, marketing and client services.
**Michael Woodruff**, director of technology and operations, advances to vice president, technology and operations.

Changes at RF Industries, San Diego, CA:
**Arthur Ekroos** leaves Saber Equipment, Fairfield, CT, to join RF Neulink as director of marketing and sales.
**Richard LaFay,** vice president of product development, advances to president of the RF Connectors division.

**Larry Whelan** departs Wonderware as vice president of international operations to join Subscriber Computing, Irvine, CA, as vice president of sales and marketing.

**D. Lynn Mercer**, product engineering director for Lucent Technologies' Columbus, OH, manufacturing plant, moves up to vice president of product realization, Mount Olive, NJ.

**Gailand Childs**, owner and operator of Childs Corp., the antenna distribution business that he started in 1977, died Feb. 15, 1997. He was 66. **Elin Childs** takes over as president, **Robert Childs** as vice president of manufacturing and **Bruce Childs** as vice president of sales.

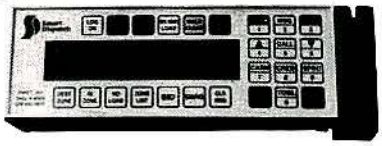
**Dennis Craig** departs Motorola, Schaumberg, IL, as manufacturing operations manager, component products group, to join Illinois Superconductor, Mount Prospect, IL, as vice president of manufacturing.

TX RX Systems, Angola, NY, appoints **Jack and Marilyn Manon** of Manon Engineering, Kirkland, WA, as its Northwest manufacturer representatives.

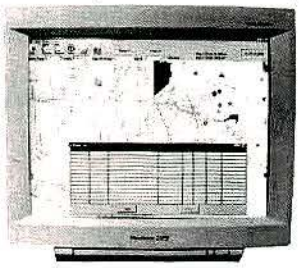

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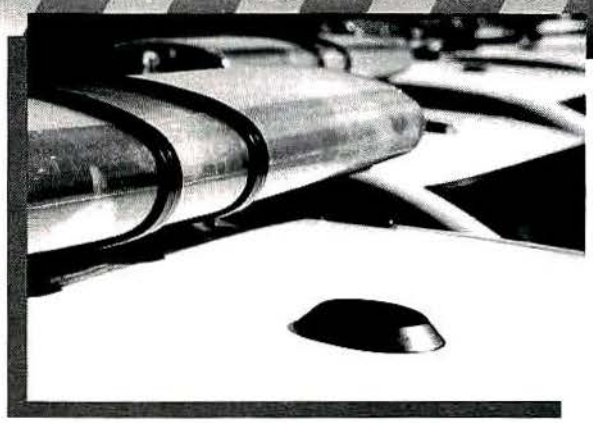
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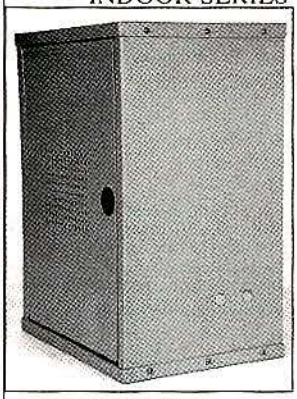
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| 400 | DIRECTOR II pagers with chargers UHF | $20 ea. O |
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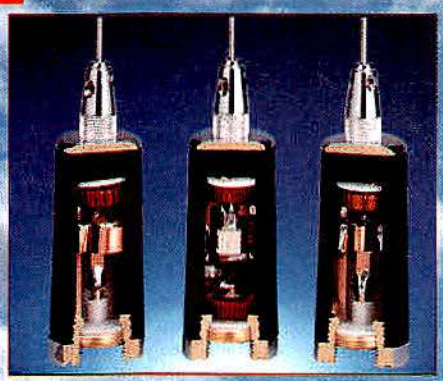
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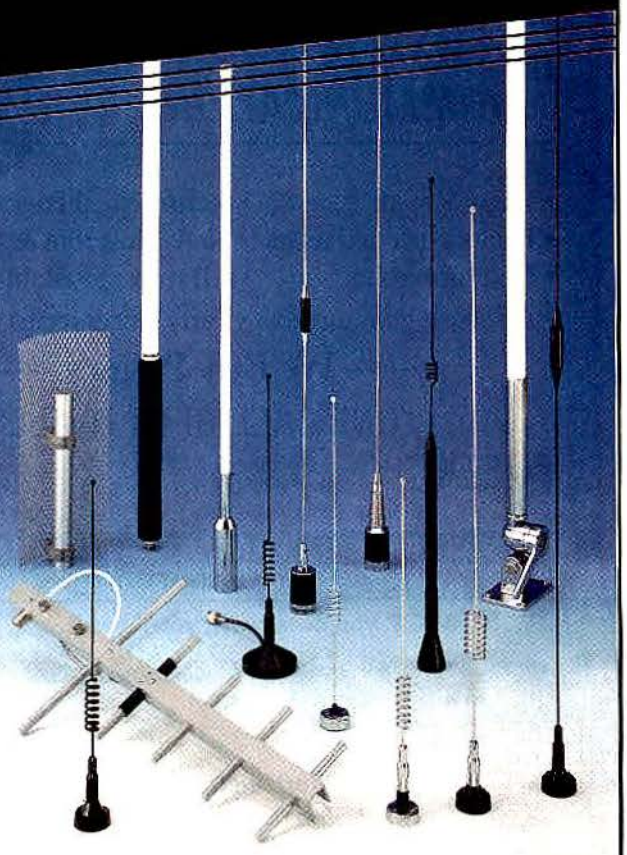
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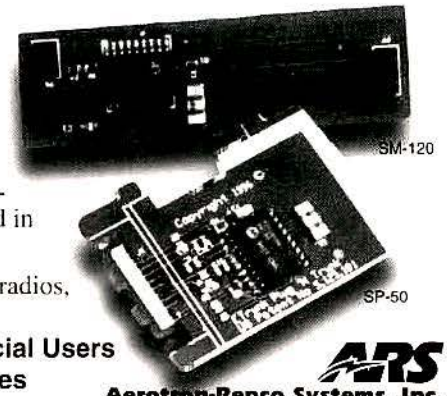
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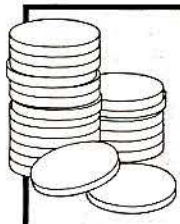
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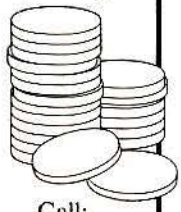
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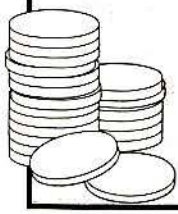
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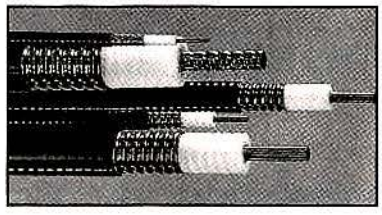
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| JOHNSON CHALLENGER 7172 UHF 488-512 MHz w/acc | $150 |
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| KENWOOD TK-930 800MHz LTR w/acc | $195 |
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| UNIDEN SMS925TS 900MHz LTR | $175 |
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| UNIDEN FMS810TS 800MHz mobile | $60 |
| MOTOROLA MTX-8000 D3 | $295 |
| MOTOROLA MTX-800 1-system | $250 |
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| MOTOROLA MTX 900 CLASSIC H25JBF5184BN GOOD CONDITION | $295 |
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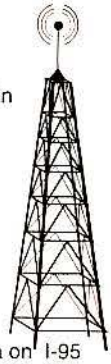
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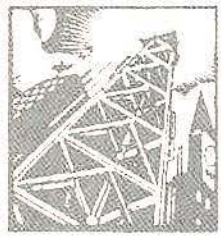


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| Northwest Indiana Comms | 114 | 181 | 219-462-2060 |
| Optoelectronics Inc. | IFC | 1 | 800-327-5912 |
| Otto Communications | 34 | 27 | 708-428-7171 |
| PageCo International Inc. | 102 | 154 | 954-776-0031 |
| PageCorp Industries | 102 | 152 | 800-957-8700 |
| Polaris Industries | 108 | 164 | 404-872-0722 |
| Polyphaser Corp. | 93 | 90 | 800-325-7170 |
| Radio Express Inc. | 104 | 157 | 703-266-1928 |
| Radiomate | 86 | 75 | 800-346-6442 |
| RCC Consultants | 150 | 99 | 902-636-6970 |
| RCW Distributing | 108 | 165 | 800-726-9015 |
| RELM Communications | 47 | 38 | 800-821-2900 |
| Ritron Inc. | 42, 44 | 34,36 | 800-USA-1USA |
| Roamer One | 74 | 63 | 800-306-ROAM |
| Selectone | 72 | 61 | 510-781-5432 |
| Sentry Manufacturing Co. | 102 | 153 | 405-224-6780 |
| ServiceWare Corp. | 96 | 96 | 819-770-4000 |
| Sharp Communication | 112 | 173 | 800-548-2484 |
| Shure Brothers Inc. | 67 | 56 | 800-25-SHURE |
| Sinclair Technologies Inc. | 38 | 30 | 800-263-3275 |
| Smartrunk | 55 | 45 | 510-887-1950 |
| Softwright | 116 | 184 | 303-344-5486 |
| Sonic Communications Inc. | 12 | 9 | 800-688-1944 |
| Sti-Co Industries Inc. | 14 | 11 | 716-662-2680 |
| Survey Technologies Inc. | 40 | 32 | 503-591-5986 |
| Sutter Buttes Two-Way | 115 | 179 | 916-674-7532 |
| Tad Radio | 91 | 85 | 250-545-1150 |
| Telewave Inc. | 75 | 64 | 415-968-4400 |
| Bobby G. Thompson | 100 | 151 | 602-460-1874 |
| Thunder Eagle | 65 | 54 | 703-242-0122 |
| Times Microwave Systems | 39 | 31 | 203-949-8400 |
| TPL Communications Inc. | 68 | 57 | 213-256-3000 |
| Transcrypt International Ltd. | 3 | 5 | 800-894-2609 |
| Trident Micro Systems | 30 | 23 | 800-798-7881 |
| Trilogy Communications Inc. | 59 | 48 | 601-932-4461 |
| Tripp Lite | 76 | 65 | 312-755-8741 |
| Trylon Manufacturing Co., Ltd. | 95 | 94 | 519-669-5421 |
| TX RX Systems Inc. | 92 | 87 | 716-549-4700 |
| U Trunk Repeaters | 112 | 174 | 619-469-3077 |
| Vega, A Mark IV Co. | 1 | 4 | 818-442-0782 |
| Vertex/Yaesu USA | IBC | 2 | 310-404-2700 |
| Vocom Products Co. LLC | 92 | 88 | 800-USA-MADE |
| Wacom Products | 91 | 86 | 817-848-4435 |
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Circle (2) on Fast Fact Card



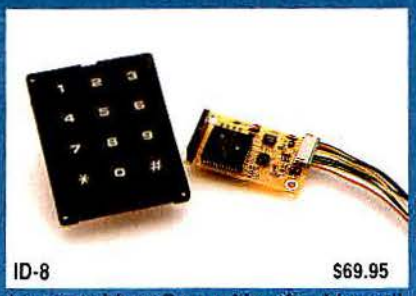

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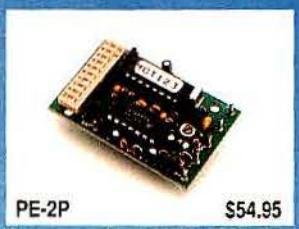

**CC-1/CR-1** $49.95 each

Surface Mount Component Kits for repairing SMT circuits. CC-1 for capacitors/CR-1 for resistors.



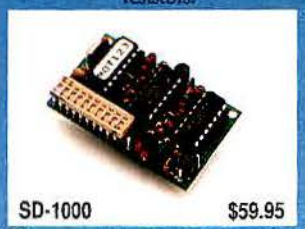
**PE-1000** $224.95

Desktop Paging Encoder. Two-tone sequential, other formats available. 7.5" x 7.8" x 2.7"



**PE-2P** $54.95

Two-tone Sequential Encoder. Sub-assembly mounts inside radio or other enclosure. Multiple call capability. 1.25" x 2.0" x .4"



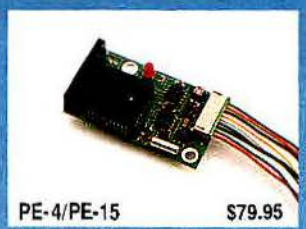
**SD-1000** $59.95

Two-tone Sequential Decoder. Programmable unit provides switched outputs from two-tone paging calls. 1.25" x 2.0" x .4"



**DTD-1** $49.95

Single Function DTMF Decoder. Provides switch outputs via DTMF. 1.25" x 2.0" x .4"



**PE-4/PE-15** $79.95

Multiple Call POCSAG (RPC-I) Paging Encoders. Where direct control of local area paging is desired. 1.78" x 1.03" x .35"



**DCS-23** $59.95

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**TS-32P** $57.95

Programmable CTCSS Encoder-Decoder. Tone squelch for any FM transceiver. 1.25" x 2.0" x .4"



**TS-64** $54.95

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